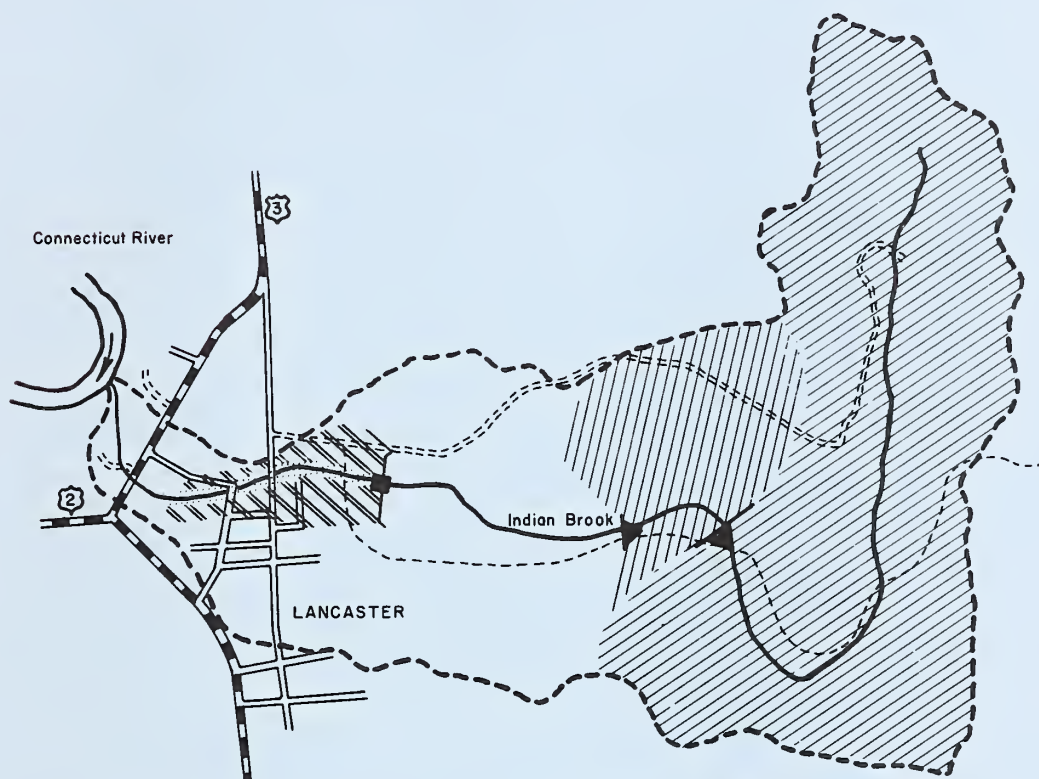


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INDIAN BROOK WATERSHED

Lancaster, Coos County, New Hampshire



WORK PLAN

for

Watershed Protection

Flood Prevention

Fish and Wildlife Development

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ADDENDUM

INDIAN BROOK WATERSHED WORK PLAN Lancaster, Coos County, New Hampshire

September 1975

INTRODUCTION

This addendum was developed in accordance with phase in procedures adopted by the Water Resources Council for Level C plans for which field studies, analyses and evaluations were completed as of October 25, 1973, and which have been formulated in accordance with Senate Document 97 as supplemented and amended.

DISCOUNT RATE COMPARISON

The work plan was developed using a discount rate of 5-7/8 percent. The costs and benefits listed below are based on a discount rate of 6-1/8 percent.

With secondary benefits:

Average annual benefits	- \$ 19,130
Average annual costs	- \$ 13,400
Benefit-cost ratio	- 1.4:1

Without secondary benefits:

Average annual benefits	- \$17,530
Average annual costs	- \$13,400
Benefit-cost ratio	- 1.3:1

ABBREVIATED ENVIRONMENTAL QUALITY PLAN

Lancaster, New Hampshire, is in many ways a unique community combining the beauty and quaintness of the typical "quiet New England town". With the natural environment of the White Mountains and the Connecticut River Valley, it is becoming a year round attraction for tourists and recreationists. Summer homes are increasing and many are being winterized to permit participation in skiing and other winter activities.

The forest, fish and wildlife, and associated resources contribute to the local environmental quality, and offer scenic beauty to tourists. Increasing pressures to utilize these resources underlines the need for wise, long term management decisions. Planned access is a particular need to prevent deterioration of the resources. Urban development must be directed carefully to minimize flood hazards and protect environmental quality.

Objectives

This environmental quality plan has been developed based on the following four objectives:

1. Maintain and enhance the quality of watershed land; improve its capability to retard runoff and minimize erosion; and provide for nondestructive access means for hunting, fishing and recreational use.
2. Preserve the quality of flood plain land in the 13-acre urban portion, the 17 acres of flood plain land interspersed within the urban area, and the remaining 20 acres of flood plain land.
3. Improve the quality of 30 acres of land and streamflow within the urban area of the watershed. This involves water quality problems associated with septic systems which are inoperative during periods of high streamflow which generates prolonged high water tables within the flood plains.
4. Preserve and enhance an area of about 30 acres of natural wetland and 140 acres of upland for wildlife habitat in the upper reaches of Indian Brook.

Formulation of the Environmental Quality Plan

Coordination: The development of the plan entailed discussion of many proposals and concerns, and includes inputs from local, state and federal groups.

Formulation: To meet the objectives, the plan proposes land treatment, channel work in the urban reach, and nonstructural measures.

The land treatment phase of the selected plan, outlined on pages 37 and 38 of the work plan, was adopted for this abbreviated environmental quality plan.

Channel improvement was selected as an aid to improve the quality of the urban land. Flood plain management was selected as a more favorable option than relocation of homes, more sophisticated floodproofing systems, and more stringent flood plain regulations. Land acquisition seemed a more desirable way to preserve the environmental quality of the marsh and wildlife habitat than the single-purpose fish and wildlife structure.

The Abbreviated Environmental Quality Plan

This plan would include land treatment, structural and nonstructural phases.

Land Treatment: This phase would be identical to that of the selected plan, and the costs, benefits, and effects would be the same.

Structural Phase: This would consist of about 3,000 feet of channel work as proposed in the selected plan. Construction operations, disposal of excess material, and provisions for safety and health would comply with local, state and federal regulations. Pollution would be controlled by temporary seedings, dust suppression and proper management of sewage, chemicals, and petroleum products on the construction site.

No person, farm or business operation would be displaced, and no archeological or historical values disturbed by the channel work.

The time required to install the structural measures would be about two years. About seven acres of perpetual easements would be needed to permit construction and operation and maintenance operations. Land use in the area needed is about 6.5 acres of native grass and shrubs and 0.5 acre in the old channel. The affected reach is almost equally divided into hayland, forest land and urban area. Residential lawns border the stream.

Nonstructural Phase: This would consist of land acquisition and flood plain management, including floodproofing, flood insurance and zoning.

Acquisition of 30 acres of wetlands and 140 acres of upland game habitat, through purchase or permanent easement by the town or a state agency, would permit preservation and enhancement of environmental quality. Upland game habitat enhancement on 100 acres of powerline rights-of-way would also be arranged.

Protection of 16 mobile homes and 14 residences would cost about \$80,000. This would entail raising of the buildings or the installation of seals or baffles to prevent entrance of floodwater into the buildings.

Flood insurance would be in accord with provisions of the National Insurance Program, administered by the Department of Housing and Urban Development, and at an estimated annual cost of \$6,500, of which \$650 would be local costs. Present worth of this cost at 5-7/8 percent over 100 years is \$110,000.

Zoning ordinances would be adopted by the town to meet requirements of the National Flood Insurance Program, and would include both the existing and potential urban developments in the flood plain.

Explanation of Costs and Implementation

This environmental quality plan would be eligible for funding in a manner similar to the selected plan. A summary of costs is shown in table 1 attached.

There would be no significant costs for the powerline rights-of-way.

Effects and Impacts

Peak runoff, erosion and sedimentation would be reduced by improvement and maintenance of watershed vegetative cover. Land treatment measures would also improve wildlife habitat and recreation access.

The channel work would lower the water table and improve the quality of urban land.

Flood protection from a 10-year frequency storm would be provided to 16 mobile homes and 14 residences. Roads and bridges would be protected from a 12- to 25-year event.

Temporary increases in sedimentation as a result of construction will occur for about one year until vegetation is established.

Aquatic and terrestrial habitat will be disrupted temporarily along the channel.

Flood plain management techniques would either reduce or partially reimburse for floodwater damages, and the use and value of flood plain lands would be affected as to future uses.

The 37 acres of presently undeveloped land would be limited to uses consistent with the continuing flood hazard, such as wildlife habitat, agriculture or other uses.

The 30 acres of wetland and the 140 acres of upland surrounding it would be preserved for fish and wildlife habitat, and the 100 acres of powerline rights-of-way would be available for upland game habitat.

TABLE 1

Abbreviated Environmental Quality Plan
INDIAN BROOK WATERSHED
Lancaster, Coos County, New Hampshire

COST DISTRIBUTION

LAND TREATMENT

Treatment of Land Areas	\$ 66,600
Technical Assistance	<u>14,100</u>
Subtotal - Land Treatment	\$ 80,700

NONSTRUCTURAL PHASE

Application	\$ 212,000
Engineering and Technical Assistance	<u>32,000</u>
Subtotal - Nonstructural	\$ 244,000

STRUCTURAL PHASE

Construction	\$ 34,000
Land Rights	40,000
Engineering	<u>4,000</u>
Subtotal - Structural	\$ 78,000

RELOCATION PAYMENTS

PROJECT ADMINISTRATION

\$ 32,000

TOTAL PROJECT

\$ 434,700

DISPLAY OF ACCOUNTS FOR THE SELECTED PLAN

The following accounts display the beneficial and adverse effects of the selected plan. This is done for the components of national economic development, environmental quality, regional development and social well-being.

SELECTED PLAN

Indian Brook Watershed Project, New Hampshire NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

<u>Components</u>		<u>Measure of Effects</u>		<u>Components</u>		<u>Measure of Effects</u>	
Beneficial effects:		(Average Annual) ^{1/}		Adverse effects:		(Average Annual) ^{1/}	
A. The value to users of increased outputs of goods and services				A. The value of resources required for a plan			
1. Flood prevention		\$ 13,730		1. Floodwater retarding structure and a multiple-purpose reservoir, with fish and wildlife facilities		\$ 10,100	
2. Utilization of unemployed and underemployed labor resources				Project installation OM&R		\$ 1,900	
a. Project construction and OM&R		\$ 3,700		2. Project administration		\$ 1,000	
Total beneficial effects		\$ 17,430		Total adverse effects		\$ 13,000	
				Net beneficial effects		\$ 4,430	

^{1/} 100 years at 5-7/8 percent interest.

SELECTED PLAN

Indian Brook Watershed Project, New Hampshire
REGIONAL DEVELOPMENT ACCOUNT

<u>Components</u>		<u>Measure of Effects</u> <u>Regional</u>	<u>Rest of</u> <u>Nation</u>	<u>Measure of Effects</u> <u>Regional</u>	<u>Rest of</u> <u>Nation</u>
<u>Income:</u>		<u>Components</u>		<u>Measure of Effects</u> <u>Regional</u>	
<u>Beneficial effects:</u>		<u>Adverse effects:</u>		<u>(Average Annual)</u> <u>1/</u>	
A. The value of increased output of goods and services to users residing in the region		A. The value of resources contributing from within the region to achieve the outputs			
1. Flood prevention		1. Floodwater retarding structure and a multiple-purpose reservoir and fish and wildlife facilities			
2. The utilization of regional unemployed or underemployed labor resources		Project installation		\$ 2,600	
a. Project construction and OM&R		OM&R		\$ 1,900	
3. Secondary		2. Project administration		\$ 150	
Total beneficial effects		Total adverse effects		\$ 4,650	
		Net beneficial effects		\$14,380	

1/ 100 years at 5-7/8 percent interest.

SELECTED PLAN

Indian Brook Watershed Project, New Hampshire
REGIONAL DEVELOPMENT ACCOUNT (cont'd)

<u>Components</u>		<u>Measure of Effects</u> <u>Regional</u> <u>Rest of</u> <u>Nation</u>		<u>Components</u>		<u>Measure of Effects</u> <u>Regional</u> <u>Rest of</u> <u>Nation</u>	
Employment:				Employment:			
Beneficial effects:				Adverse effects:			
A. Increase in the number and types of jobs				A. Decrease in number and types of jobs		None	
1. Employment for project construction		7 semi-skilled jobs for 1 year		Net beneficial effects		1/3 permanent semi-skilled jobs annually	
2. Employment for project OM&R		1/3 permanent semi-skilled jobs annually				- 7 semi-skilled jobs for 1 year	

SELECTED PLAN

Indian Brook Watershed Project, New Hampshire
ENVIRONMENTAL QUALITY ACCOUNT

Components

Measure of Effects

Beneficial and adverse effects:

A. Areas of natural beauty.

1. Preserve a 23 acre marsh and woods and a 22 acre marsh area.
2. Create a 52 acre open space permanent pool including the 22 acre preserved marsh area.
3. Inundate 54 acres of marsh and woods and a 600 foot stretch of stream.
4. Disruption in tranquility of rural environment by an added 175 hunter and fisherman visitor-days.
5. Modify 2450' of naturally flowing and 550' of a formerly modified stream in the urban area of Lancaster.

B. Quality considerations of water, land, and air resources.

1. Reduce erosion on 1,245 acres of cropland, forest land and other land.

2. Increase sedimentation and turbidity of stream during construction and vegetation establishment phases.

C. Biological resources and selected ecosystems.

1. Enlarge by 30 acres habitat for fish and waterfowl.
2. Provide 59 acre resting area at the reservoir for migratory waterfowl.
3. Inundate 600' of stream having limited population of brook trout, suckers and minnows.
4. Inundate 38 acres of woodland habitat in an area of comparable habitat of 1190 acres.

D. Irreversible or irremediable commitment.

1. Commitment of 177 acres of grass, woods, and marshes to open and green space.

SELECTED PLAN

Indian Brook Watershed Project, New Hampshire
SOCIAL WELL-BEING ACCOUNT

<u>Components</u>	<u>Measure of Effects</u>
Beneficial and adverse effects:	
A. Real income distribution.	A. Data not available.
B. Life, health and safety.	B. Provide one percent level of flood protection.
C. Recreational opportunities.	C. Creates in excess of 150 visitor-day activities for hunters and fishermen.

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WATERSHED WORK PLAN

for

WATERSHED PROTECTION, FLOOD PREVENTION, AND FISH AND WILDLIFE DEVELOPMENT

INDIAN BROOK WATERSHED

COOS COUNTY

NEW HAMPSHIRE

September 1975

WATERSHED WORK PLAN
INDIAN BROOK WATERSHED
NEW HAMPSHIRE

Prepared under the Authority of the Watershed
Protection and Flood Prevention Act (Public Law
566, 83d Congress, 68 Stat. 666) as amended.

Prepared by:

Town of Lancaster, New Hampshire
Coos County Conservation District
New Hampshire Fish and Game Department
New Hampshire Water Resources Board

With assistance by:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

SEPTEMBER 1975

WATERSHED WORK PLAN AGREEMENT

Between the

Town of Lancaster
Local Organization

Coos County Conservation District
Local Organization

New Hampshire Fish and Game Department
Local Organization

New Hampshire Water Resources Board
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of New Hampshire

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

WHEREAS, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Indian Brook Watershed, State of New Hampshire, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended, and

WHEREAS, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service, and

WHEREAS, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Indian Brook Watershed, State of New Hampshire, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement

NOW, THEREFORE, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan and further agree that the works of improvement as set forth in said plan can be installed in about five years.

IT IS MUTUALLY agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations, provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire such land rights as will be needed in connection with the works of improvement. The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Land Rights Cost</u> (dollars)
Multiple-purpose Str. #1 and fish and wild- life facilities.			
Payment to landowners for about 70 acres for water resource improve- ment.	50	50	9,000
Payment to landowners for about 70 acres for fish and wildlife facilities	100	0	8,900
Legal fees, survey costs, flowage easements, and other	100	0	600
All other structural measures	100	0	43,200

The Sponsoring Local Organization agrees that all land acquired or improved with PL 566 financial or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the sponsoring local organization and the Service as follows.

	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Relocation Payment Costs</u> (dollars)
Relocation Payments	45.4	54.6	0 ¹ /

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.
4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Construction Cost</u> (dollars)
Multiple-purpose Structure No. 1	19.6	80.4	53,100
Fish and Wildlife Facilities at Structure No. 1	50.0	50.0	20,000
Floodwater Retarding Structure No. 2	0	100.0	50,700
Channel Modification	0	100.0	33,900

The Sponsoring Local Organization will provide a portion of its share of the construction costs by performing elements of the project work with its own labor forces, equipment, and/or materials in lieu of cash.

The quantity and value of such work will be determined by mutual agreement immediately prior to the signing of the appropriate agreement and will be set forth in the project agreement.

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organization (percent)</u>	<u>Service (percent)</u>	<u>Estimated Construction Cost (dollars)</u>
Multiple-purpose Structure No. 1	0	100	4,400
Fish and Wildlife Facilities at Structure No. 1	100	0	2,000
Floodwater Retarding Structure No. 2	0	100	3,700
Channel Modification	0	100	4,200

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be \$2,600 and \$14,800 respectively.
7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation plans on their land.
8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.
9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.
11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.
12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties. An amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the sponsor(s) having specific responsibilities for the particular structural measure involved.
14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.
16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Town of Lancaster
Local Organization
By Richard Martin
Title Chairman, Board of Selectmen
Address Lancaster, NH 03504
Zip Code
Date December 15, 1975

The signing of this agreement was authorized by a resolution of the
governing body of the Town of Lancaster
Local Organization
adopted at a meeting held on December 10, 1975

Robert J. Smith
(Secretary, Local Organization)
Address Lancaster, NH 03504
Zip Code
Date December 15, 1975

Coos County Conservation District
Local Organization
By Eduard C. Fitzgerald
Title Chairman
Address Colbrook, N.H. 03576
Zip Code
Date 12-29-75

The signing of this agreement was authorized by a resolution of the
governing body of the Coos County Conservation District
Local Organization
adopted at a meeting held on _____

Randell D. Sargent
(Secretary, Local Organization)
Address Lancaster, NH 03584
Zip Code
Date _____

New Hampshire Fish and Game Department
Local Organization

By *Bernard H. Gordon*
Title Director
Address 34 Bridge St., Concord, NH 03301
Date March 5, 1976 Zip Code

The signing of this agreement was authorized by a resolution of the governing body of the New Hampshire Fish and Game Department
Local Organization
adopted at a meeting held on MARCH 4, 1976
Bernard H. Gordon
(Secretary, Local Organization)

Address 34 Bridge St., Concord, NH 03301
Date March 4, 1976 Zip Code

New Hampshire Water Resources Board
Local Organization

By *George M. McLee Sr.*
Title Chairman
Address 37 Pleasant St., Concord, N.H. 03301
Date January 6, 1976 Zip Code

The signing of this agreement was authorized by a resolution of the governing body of the New Hampshire Water Resources Board
Local Organization
adopted at a meeting held on January 20, 1966
Thomas H. Smith
(Secretary, Local Organization)

Address 37 Pleasant St., Concord, N.H. 03301
Date January 6, 1976 Zip Code

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WATERSHED WORK PLAN
INDIAN BROOK WATERSHED
Coos County, New Hampshire

September 1975

SUMMARY OF THE PLAN

Indian Brook Watershed is located in the town of Lancaster, Coos County, New Hampshire. It is 2.2 square miles (1,420 acres) in size. This plan for watershed protection, flood prevention and fish and wildlife development is sponsored by the Town of Lancaster, the Coos County Conservation District, the New Hampshire Fish and Game Department, and the New Hampshire Water Resources Board. The plan is prepared under the authority of the Watershed Protection and Flood Prevention Act (PL 566), as amended.

The problems in the watershed which this plan covers are flooding of urban and agricultural areas and erosion and sediment in the urban areas. The project will provide a 100-year level of protection against flooding on 30 acres in the urban area, which includes 14 residences and 16 mobile homes. In addition, the project will help fulfill a need for improved fish and wildlife habitat in the Lancaster area. It will provide a 140-acre public fish and wildlife area which includes a boat ramp, parking area, and a 52-acre marsh.

The works of improvement planned to solve these problems are land treatment and structural measures. All measures are planned to be installed during a 5-year period.

Land treatment measures include such conservation practices as pasture and hayland management, recreation area improvement, wildlife habitat management, critical area planting, forest buffer zones, natural area preservation, and installation of sediment traps. Community planning assistance will also be available to the Town of Lancaster.

Structural measures include a multiple-purpose structure (structure 1) with a fish and wildlife development including an access road, parking area and boat ramp, a floodwater retarding structure (structure 2), and about 3,000 feet of channel work including a grade stabilization structure.

With the installation of the land treatment measures, hydrologic conditions will improve and peak runoffs will be reduced by 5 percent. Land treatment will help maintain low erosion rates.

The channel work will enlarge the existing channel and will have some influence on lowering ground water levels up to 500 feet away from the channel. After the land treatment and structural measures have been installed, land within the urban area, where water and sewer services are available, will be protected from flooding.

A 52-acre shallow fresh water marsh with public access will be created to provide habitat for fish and wildlife at site 1. Public access is not provided to floodwater retarding site 2.

The total estimated installation cost of land treatment and structural measures is \$331,800. The Public Law 566 share of this amount is \$181,100 with other funds providing the remaining \$150,700. The land treatment cost is \$80,700 of which \$12,200 is to be provided by PL 566 for accelerated technical assistance. The costs of the floodwater retarding structure, the multiple-purpose structure and the fish and wildlife facilities total \$155,500 of which PL 566 will bear \$116,000 and other funds \$39,500. The cost of the channel work is \$78,200 of which PL 566 will bear \$38,100 and other funds \$40,100.

Individual landowners and operators will bear the costs of treatment measures applied to private land. The Town of Lancaster will bear the cost of installing measures on town land. Technical assistance to install the measures will be funded through PL 566 and existing federal, state and local programs.

The sponsors' share of the cost for structural measures will be met with funds appropriated by their existing program authorities. The New Hampshire Water Resources Board finances land rights and other costs through capital budget requests. The Fish and Game Department will use its own work force and equipment and Pittman-Robertson funds. The Town of Lancaster will use budget requests and its own work force.

PL 566 funds will bear 80.4 percent of the construction cost for multiple-purpose structure 1. The New Hampshire Fish and Game Department and Water Resources Board will bear the remaining 19.6 percent. The construction cost for the fish and wildlife development facilities will be shared equally by PL 566 and the Fish and Game Department. Construction costs for all other structural measures will be borne totally by PL 566 funds.

PL 566 funds will bear engineering services costs with the exception of costs for the fish and wildlife development facilities which will be borne by the Fish and Game Department.

The sponsors will work together to provide the necessary land rights. The Water Resources Board, if necessary, will use its powers of eminent domain to acquire land rights necessary to build, operate and maintain the flood prevention phase of the structural measures. Land rights acquisition will be in accordance with the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970" (Public Law 91-646). Displacement of persons, businesses or farm operations is not anticipated.

PL 566 and the Water Resources Board will share equally the land rights costs for the multiple-purpose reservoir at site 1. The Fish and Game Department will bear the total land rights costs for the fish and wildlife facilities adjacent to site 1. The Water Resources Board will bear the land rights costs for site 2. The Town of Lancaster is responsible for the channel work and grade stabilization structure.

The Water Resources Board will administer all construction contracts except for the fish and wildlife development facilities. These will be administered by the Fish and Game Department.

Individual landowners and operators will manage and maintain all land treatment measures. The New Hampshire Water Resources Board will operate and maintain the structural works of improvement at sites 1 and 2. The Fish and Game Department will operate and maintain stop logs at site 1. The sponsors will provide public access to the multiple-purpose reservoir and fish and wildlife development. The Town of Lancaster will operate and maintain the channel and grade stabilization structure. The annual cost for operating and maintaining the structural measures is estimated to be \$1,900 for flood prevention measures and \$1,300 for fish and wildlife measures.

The average annual benefit from structural works of improvement is estimated to be \$19,030 and the annual cost \$13,000.

The project has a benefit-cost ratio of 1.5:1.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

Indian Brook watershed is located in the town of Lancaster, Coos County, in northern New Hampshire. It lies on the northwestern fringe of the White Mountain National Forest about 110 miles north of Concord, New Hampshire and is within the Connecticut River Basin. Approximately 250 people live in the 2.2 square mile (1,420 acre) area of the watershed.

According to the delineations of the Water Resources Council, Indian Brook watershed lies within the following:

Water Resource Region: New England (01)
Water Resources Subregion: The Connecticut River (08)
Major Land Resource Area: Northeastern Forage and Forest Region (R)
Land Resource Subarea: New England and Eastern New York Upland (144)
Land Resource Group: Northeastern Mountains (66)
OBE Economic Area: Burlington, Vermont (003)

The above land use and land resource categories describe the Indian Brook watershed as a region of forest and pasture or hay land.

Indian Brook poses specific problems that are of concern to local residents. The primary problem in the watershed is flooding along Indian Brook in the urban area of Lancaster. The problem area comprises about 50 acres of flood plain land containing about 5 acres of pasture and hay land, 13 acres of urban area and 32 acres of forest land. Although minor in comparison, accompanying erosion and sedimentation in the urban area augments the problem. The greatest damage occurs in residential areas although some transportation and agricultural damage also occurs.

There are three major soil groups in the watershed. Ten percent of the watershed area (the Connecticut River flood plain and terraces) contains silty and sandy loams well-suited for agriculture, recreation areas, and in areas not susceptible to flooding, urban development. About 25 percent of the watershed, primarily along Indian Brook, is characterized by poorly to very poorly drained sandy loam soils. The remaining 65 percent has been formed in stony glacial till and is found on the hilly uplands. Due to their wetness, stoniness, and steep slopes, both the wetland and hilly upland soils are best suited for wildlife habitat development and forestry use.

The upland area is generally covered with a dense, relatively impervious glacial till. Granitic bedrock is encountered at shallow depths and bedrock outcroppings are visible.

The geology of the valley area differs from the upland area. Geological investigation along the lower reaches of Indian Brook indicates the presence of very loose, fine to coarse grained, fairly well graded, clean sands overlaid by silt, organic silt and muck. The very loose underlying sands were investigated to a depth of 12 feet. These sands are extremely pervious and saturated with water.

A thick layer of organic soil exists in the marshy areas at the proposed upland area sites. Organic accumulation of 24 feet was typical within the proposed reservoir area at site 1 and measurement of one location indicated an even greater depth. Up to 22 feet of organic accumulation was measured beneath the beaver flowage at site 2.

The maximum relief of the watershed is 420 feet. The highest point is 1,250 feet above sea level at the top of Page Hill. The lowest point is 830 feet at the confluence of Indian Brook with the Connecticut River.

There are no known mineral resources of commercial value in the watershed. No potential for ground water development in the watershed was identified in the Connecticut River Basin Study.

The watershed is located in Algermissen's Seismic Risk Zone 2, rated to have moderate damage potential should the area be affected by a major earthquake. Review of records in "Earthquake History of United States, Part I," indicates that the area has felt at least eight major earthquakes during the past 300 years. The most recent was in 1929 in the St. Lawrence Valley region, to the north.

The area has a modified continental climate with short, mild summers, and long, cold winters. Temperatures range from a low of -40°F to a high of 100°F and the mean January and July temperatures are 16°F and 66°F respectively. The growing season averages about 109 days and extends from about May 29 to September 15. The average annual precipitation is 37 inches and is distributed uniformly throughout the year; however, annual snowfall of about 80 inches accounts for the majority of precipitation during the winter.

About 1,190 acres, or 84 percent of the area, is forested; 55 acres, or 4 percent, is pasture and hay land; 75 acres, or 5 percent, is urban area; and 100 acres, or 7 percent, is water and marsh. About 200 acres is in forest swamp.

The watershed is in an area of northern hardwoods and conifers. The predominant hardwoods are birch, maple, beech and poplar. The conifers are fir, spruce, white pine and larch. Most of the forest land has been logged in the past, but not in recent years.

Cropland in the watershed is used primarily to produce hay for dairy cows.

The Lancaster urban area typifies much of the urban development of rural mountainous New England. Roads and railroads generally follow streams and valleys. Attempts were made to avoid frequently flooded areas, but considerations of economics and engineering made this impractical in some instances. Residential and commercial areas developed in strips and clusters along the roads with the main villages at major crossroads.

The main village of Lancaster is situated at the intersection of U. S. Highways 2 and 3 and is served by the Boston and Maine Railroad. The village includes 75 acres of the watershed area, developed for urban use in varying degrees. This includes 13 acres of residential area within the Indian Brook 100-year flood plain.

Indian Brook originates as an intermittent stream in the vicinity of Page Hill. It flows south about 2 miles, turns north-northwest through a series of beaver flowages, and, at this point, becomes a perennial stream. The stream then turns west again, flows through the urban area and enters the Connecticut River. The stream follows a natural, unmodified channel for most of its course, but in broad flat areas the channel is almost undefined.

At times beaver ponds of varying sizes have occupied some upstream reaches. Within the urban area, about 550 feet of the stream has been modified by dredging. In this area the stream is in a well defined channel 5 to 10 feet wide and 2 to 3 feet deep. The channel is bordered generally by hayland or residential lawns with alders growing on the streambank. In the urban area four road bridges and two railroad bridges cross the brook. Further downstream, Indian Brook enters the flood plain of the Connecticut River in a deeply-entrenched, tree-lined channel.

The Town of Lancaster has a public sewer system which serves the village area of the town. A secondary level of treatment is accomplished by a system of stabilization ponds. Design specifications are as follows:

Dry weather sanitary flow	0.4 MGD (million gallons per day)
Peak sanitary flow	2.4 MGD
Combined sewer peak inflow	26.6 MGD
Population (maximum)	4,000 persons

The system is presently working at about one half its design capacity and serves about 2,000 persons.

Collection mains have recently been extended to serve the part of town in the area of Indian Brook. Eventually, all residents in this area are expected to connect onto the system. Until they do, they will continue to use septic systems for waste disposal. The Town requires all new development in the service areas to tie into the public system.

In the urban area the brook is subject to effluent discharges from inadequate septic systems, especially during periods of high runoff or prolonged wetness. Septic systems operate during dry periods of the year when the water table is drawn down, but may become inoperative during and after stages of high streamflow which raise groundwater levels to near the surface of the land.

The New Hampshire Water Supply and Pollution Control Commission has classified Indian Brook as a Class B stream. Waters of streams in this classification are acceptable for bathing and recreation, fish habitat, and public water supply after adequate treatment. However, water quality has been impaired within the urban reach of Indian Brook by the effluent from inoperative septic systems during wet periods.

The New Hampshire Water Supply and Pollution Control Commission has sampled Indian Brook in Lancaster below the Route 3 bridge and reports on the following properties:

Date collected	September 10, 1973
Temperature	12.0°C (53.6°F)
Total coliform	32 count per 100 ml
Biochemical Oxygen Demand - 5 day	1.0 mg/l
Dissolved oxygen	5.9 mg/l
Dissolved oxygen saturation	55%
pH	6.4 units
Alkalinity as CaCO ₃	28 mg/l
Cadmium Cd	< .05 mg/l
Calcium Ca	12.0 mg/l
Chloride Cl	1.1 mg/l
Color	160 units
Copper	< .05 mg/l
Fluoride F	< .1 mg/l
Hardness CaCO ₃	56 mg/l
Iron Fe	6.3 mg/l
Magnesium Mg	2.6 mg/l
Manganese Mn	.16 mg/l
Nitrogen (Ammonia)	.125 mg/l
Nitrogen (Nitrite)	.018 mg/l
Phosphorus (Ortho)	.036 mg/l
Phosphorus (Total)	.097 mg/l
Sodium Na	13.5 mg/l
Specific Conductivity	150 micro-mhos
Sulfate SO ₄	14.5 mg/l
Total Solids	123 mg/l
Suspended solids	6 mg/l
Turbidity	10.0 JTU
Zinc Zn	.20 mg/l

In addition a considerable amount of fiber was found floating in the water. Plankton identification included a few unidentified flagellate and ciliate protozoa and an unidentified species of euglena. Stream-flow was low at the time the sample was taken.

The Environmental Protection Agency's data bank and the New Hampshire Water Supply and Pollution Control Commission's files have been checked for any existing water quality data on Indian Brook. However, no data were found, and no other known data are available.

Base flows of about 0.2 cfs can be expected at the proposed reservoir sites, with water temperatures in the 60 to 70°F range during the summer months.

Occasionally warm weather and pooling in upstream beaver ponds will warm the water to temperatures above 70°F. There are no normal activities above the proposed sites which will degrade the quality of water. However, the water in the stream is often visibly colored by the organic material in the marshes.

Beaver ponds and marshes are evident along the main stream. Based on criteria provided in U. S. Fish and Wildlife Service Circular C-39, 100 acres of wetland would be classified as Type 3 - inland shallow fresh marshes, and 200 acres as Types 6 and 7 - shrub and wooded swamp areas.

Septic systems which contribute pollutants during periods of high stream-flow are the only known point sources of pollution. No dairy cattle are fed or housed in the watershed.

Pollution from nonpoint sources could result from use of fertilizer on the 55 acres of pasture and hay land and from the use of fertilizers and pesticides in the urban area.

Economic Data

The economy of the Lancaster area is based on four major activities: farming, forestry, recreation and manufacturing.

There are parts of four dairy farms in the watershed. These farms average about 50 acres in size. Farming as a whole is a major source of income to many landowners in the region. The primary crops are hay and corn.

The majority of the land in the watershed is forested and has potential for timber production. It has been logged in the past, and logging will probably continue in the future. Hardwood sawlog and pulpwood markets are excellent as are the markets for most softwood products. The manufacture of wood-related products is the major employment source in the region.

The watershed population is about 250 persons, 100 of which live on the flood plain. The population in the town of Lancaster was 3,166 in 1970 according to Bureau of Census figures, an increase of 28, or 1 percent, from 3,138 in 1960. In comparison, the population of Coos County was 34,291 in 1970, a decrease of 2,849, or 8 percent, from 37,140 in 1960. Population projections for the town of Lancaster indicate a population of 3,300 by 1990 and 3,700 by the year 2020, a growth rate of about 0.3 percent.

Employment within the watershed is limited to three commercial establishments and farming and logging operations. Lancaster and the surrounding towns are the major employment centers in the area.

The majority of land in the watershed is privately owned. Public ownership is limited to about 150 acres of town forest. Outside the urban area there are about 20 landowners, four of whom are farmers.

Land value in the upland wooded areas runs at about \$100 per acre. Flood plain land in the lower reaches of the watershed, which is primarily forested wetland, is valued at about \$50 per acre. One-fourth acre house lots with public water and sewer sell for about \$1,200.

Over the years, much of the North Country of New Hampshire, including the Lancaster area, has experienced an outward migration of its younger people, primarily because of the lack of employment opportunities. The closing of some wood product manufacturing operations has reduced manufacturing jobs and the opportunities for work in the woods. The increased mechanization necessary to compete in today's markets further reduces manpower needs.

Although employment data for the watershed or the town of Lancaster is not available, data is available for Coos County. The downward trend in employment opportunities can be seen from data gathered by the New Hampshire Department of Employment Security for the 1955-1963 period. Covered employment (employment covered under the Federal Employment Security Act) for this period dropped from 9,287 to 7,702 within Coos County. This has stabilized, however, as employment through 1969 remained in the 7,800-7,900 range. Underemployment, indicating the lack of year-round employment, exists in the county. Because of the summer tourist and recreation business, the labor force and employment opportunities in the county fluctuate. A special compilation by the Department of Employment Security for the summer of 1963 revealed that the labor force within Coos County numbered about 17,100, of which 2,700 persons were temporary residents from outside the county. The total number employed was about 16,450 resulting in an unemployment rate of 3.8 percent. During the following winter from December to April, the labor force was about 14,300 with 13,240 being employed, resulting in a 7.4 percent unemployment rate.

The median income of \$8,137 for families in Coos County and \$7,967 in Lancaster is less than the state average of \$9,698 as reported by the 1970 U. S. Census of the Population. Factors related to the lower level of income are a high dependency ratio, high rates of unemployment and underemployment, low self-employment income, a relatively large number of elderly people on fixed incomes, a relatively small number of people receiving interest and dividend income and few employment opportunities for women.

Historically, agriculture and lumber industries have dominated the economy of the region. Agriculture has declined. The lumber and wood product industries remain a significant factor employing about 30 percent of the labor force. There has also been growth in the smaller, more diversified industries. The continued growth of the recreation and tourist industries holds significant potential for the area's development.

An adequate transportation system connects the town, farms and markets. U. S. Routes 2 and 3 join within the watershed boundaries, and the town is about 30 miles from I-93 and I-91. Two railroad tracks cross the watershed.

The watershed is within an area designated as a "redevelopment area" under Title IV of the Public Works and Economic Development Act of 1965. It is also in the North Country Resource Conservation and Development Project Area. Improvement of the overall economy of the area has been the objective of the above programs.

Fish and Wildlife Resources

The watershed provides a range of habitat for many species of wildlife. About 84 percent of the watershed is in woodland, predominantly northern hardwoods and conifers. The plant community consists of maple, beech, and birch, interspersed with spruce, fir and white pine. The pure conifer stands are more boreal in makeup: black spruce, white spruce, red spruce and fir-balsam predominate. Growth is dense and heavily shaded with limited understory. This furnishes habitat for snowshoe hare, red squirrels, white-footed deer mice, warblers, ravens, and northern songbird species.

Within the woodland areas there are approximately 50 acres of pastures that were abandoned about 30 years ago. This land is in a stage of succession, going from grassland to woodland and provides excellent habitat for deer, grouse, woodcock and snowshoe hare. Vegetative cover is primarily juniper, white pine, birch, poplar and spruce-fir. Shrubs include hawthorn, red osier, dogwood, raspberry and highbush cranberry. Small openings still exist which support grasses and forbs.

Two powerlines pass through the watershed and provide about 100 acres of open areas within the forest land. Vegetative cover within the power-line rights-of-way consists mostly of grasses and shrubs. These areas provide wildlife habitat for deer, grouse, woodcock and snowshoe hare.

The 100 acres of Type 3 - inland shallow fresh water marshes provides habitat for waterfowl and furbearers. With water levels often maintained by beaver, these areas are used by mink, muskrat, black duck, wood duck, teal and golden eye ducks. Waterfowl are attracted into the watershed since it is along the Connecticut River flyway.

In the lower reaches of the watershed, 75 acres of residential land and 55 acres of pasture and hay land prevail. Alder-willow and dogwood thickets are interspersed through the area and along the stream. The open reaches along the stream are made up of a sedge-bluejoint grass community. The stream through this area is about 5 to 10 feet wide and has about one-half acre surface area.

The wildlife community along the urban reach consists of many songbirds, especially those in the warbler and sparrow families. Other species are woodchucks, skunks, field mice, shrews, frogs, toads, muskrats and garter snakes.

As a perennial stream, Indian Brook originates in the existing marsh at site 1 (see project map, figure 4). The area at site 1 is primarily marsh habitat with a dense cover of bluejoint, sedges and shrubby growth. At present the stream is dead water varying in maximum depth from 3 to 4 feet. The dead fir and larch scattered throughout site 1 show a history of varying water levels created by beaver activity. The marsh has a north-south aspect. To the east and west the cover is typically swamp with dense stands of fir and spruce growing on raised hummocks. Ground cover is sparse and is mostly sphagnum moss and associated plants such as bunchberry, snowberry and sorrel.

A beaver dam at one time flooded an area of about 7 acres at site 2, the lower marsh, but the beaver activity has ceased there in recent years. The pond is now shallow and filled with aquatic vegetation such as pondweed and duckweed. The shallow areas are covered with marsh grasses, sedges and brush.

Waterfowl are present in both marshes in the fall and some nesting takes place in the spring. A deeryard is located on the perimeter of site 1. Signs indicate a fair population of snowshoe hare around the perimeter and in the marsh habitat. There is some evidence of mink and muskrat activity; beaver activity is low.

Below site 2 the stream flows on a steep gradient, primarily through forest land. The stream is narrow in this reach and is characterized by a rocky and gravelly bottom.

The slope of the stream flattens as it passes through the urban area. The streambed is made up of sands and gravels. The New Hampshire Fish and Game Department places low significance on fishery values in this urban reach of the stream. While Indian Brook is described as a perennial stream, the summer flows in this reach are frequently very low or nonexistent and water remains only in small, shallow pools. In addition, the water quality is oftentimes poor. Effluent discharging from residential septic systems and a noticeably high coloration frequently impair the quality of the water.

In Indian Brook, minnows are the most abundant species of fish, but the brook may also support some native brook trout in the upstream reaches. Suckers use the stream to some extent for spawning. Stream - fishing - use figures have not been reported because the Fish and Game Department does not consider the stream suitable for trout stocking.

The remote, upland forested areas in the watershed are accessible by logging roads and an old logging railroad bed which generally follows the course of the stream. Most of the watershed is accessible for hunting and fishing.

The white-tailed deer is of primary importance in the watershed. It is estimated that the deer population is 15 and according to estimates by biologists of the New Hampshire Fish and Game Department, seven of the deer occupy the yard adjacent to the marsh area near site 1. The deer kill for 1971 in the town of Lancaster was about 1.52 per square mile. This indicates that three deer could have been taken from the watershed.

The grouse population in Coos County has shown some increase in the last two years. The New Hampshire Fish and Game Department reported a sighting of 87 grouse per 100 miles of census line in northern New Hampshire. Since the population of grouse is cyclic, exact populations are difficult to determine; but during periods when the grouse population is increasing, average population figures indicate 75 to 100 grouse in the watershed.

Based on average population levels for similar areas, it is estimated that 50 hare inhabit the watershed. As with grouse, the population is cyclic and exact numbers are difficult to determine.

Habitat is available for some typically northern species of birds not found in the southern part of the state. Species such as the northern shrike, Arctic three-toed woodpecker, loon, raven, and Canada jay are present and attract many observers.

There are no known rare or endangered species in the watershed.

Recreational Resources

Past recreational pursuits in the watershed have been limited to fish and wildlife-related activities. In recent years, however, many of the old logging roads and the abandoned railroad have been used by snowmobilers during the winter months.

While there are no recreation facilities in the watershed, summer and winter-based activities are available in the town. The town of Lancaster has an excellent recreation program financed in part by trust funds. The program provides picnic facilities, a swimming pool, playground, athletic fields, tennis courts in addition to well maintained parks and open space in the village area. Band concerts are enjoyed by the public during the summer months.

Private recreation areas in the town provide facilities for camping, picnicking, swimming, skiing, biking and snowshoeing. Other facilities are also available in the region, and overcrowding at many of the areas is common.

Within the watershed there is an opportunity for hiking and nature study. The abandoned railroad grade and logging roads provide physical access to the marshes and upland areas.

Archeological and Historical Values and Unique Scenic Areas

Logging operations have been an important part of the history of the Town of Lancaster and northern New Hampshire. The track bed of the former Kilkenny Railroad is one of the visible remnants and is partially located in the watershed (see project map, figure 4). The railroad was constructed in 1887 to reach the timber resources in the mountains of Kilkenny to the east. The railroad extended from near Summer Street in the village of Lancaster to a maximum of 14½ miles into the mountains and hauled out logs and sawed timber from a local mill. By 1894 much of the supply of timber had been depleted and activity on the railroad slowed. In 1897

all railroad operations came to an end and the rails were torn up. Today, the railroad is gone but the bed remains. The current use of the bed is as a trail for hiking and snowmobiling and as access to the area for hunters, fishermen and trappers. The Kilkenny railroad bed is a historical and recreational resource to the town.

In the village area there is a granite split stone culvert that carries the Boston and Maine railroad spur over Indian Brook. While similar culverts exist throughout the north country and the State, this culvert is of unique and indigenous material and construction.

The Connecticut River Valley was a primary settlement area and travel route for the American Indians. There was an Indian settlement on the Connecticut near the mouth of Indian Brook. Literature and field investigation yielded no indication of Indian activity in the upper reaches of the Brook.

Soil, Water and Plant Management Status

The majority of the upland portion of the watershed is forested and has been commercially logged in the past. There are no indications that this land use will change in the near future. The wet soils, shallow to bedrock conditions and lack of accessibility to the area will tend to restrain any development.

Urban development is encroaching on agricultural land in the lower reaches of the watershed. Land formerly used for production of hay and pasture has now become residential, and this trend is expected to continue. This area is adjacent to the business district of Lancaster, and lies within the path of urban expansion. It has public water supply, is within the proposed sewerage district, and is adjacent to major transportation and utility networks.

Soils throughout most of the town are subject to limitations for urban development. About 90 percent of the soils exhibit stoniness, wetness, hardpan, shallow bedrock and excessive slopes, or are subject to flooding. More than half of the town's population lives within a compact village, partly as a result of these natural restrictions. The town plan for Lancaster recommends the accommodation of new growth within the existing service area of the village as the most economical form of new development. Scattered and haphazard growth would make provision of essential town services costly, if not impossible. Compact, well-planned growth would improve the Town's chances of preserving the natural qualities of the community.

Projection of population and the Lancaster, New Hampshire town plan for 1990 indicate the need for 50 acres for urban expansion within the watershed. The town plan shows that this need can best be met within cost and environmental constraints by development of woodland, hayland, and idle land now interspersed within the urban area. It is estimated that 30 acres of hayland and 3 acres of forest land interspersed within the urban area and above the 100-year flood plain of Indian Brook will be

committed to urban use. It is expected that with protection of the existing residences and properties in the flood plain of Indian Brook, another 17 acres now in forest and hay land which is interspersed within the present urban area would be committed to urban development.

Forest production is relatively low. Most of the forest land is owned in small parcels with little emphasis placed on forest production. Evidence of old logging roads exists, but at present access is limited for logging operations. There is also little emphasis placed on recreation and wildlife habitat opportunities. The hydrologic cover condition of the forest land is generally good.

The use of the open land is permanent hayland with generally good hydrologic cover.

The Coos County Conservation District has an active resource conservation program. Within the watershed two of the four cooperators with the District have basic conservation plans for their units. These cooperators represent 17 percent of the watershed acreage and have applied about 10 percent of the conservation practices planned for their units.

Adequate forest fire protection is provided by the New Hampshire Division of Resources Development in cooperation with the U. S. Forest Service under the Clarke-McNary Cooperative Forest Fire Control Program. Other current Federal-State forestry programs active within the watershed include Cooperative Forest Management, Cooperative Forestation, and Cooperative Forest Pest Management. Given protection, care and management, the forest stands are expected to increase their contribution to the economy of the watershed.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land Treatment

The Coos County Conservation District has an on-going land treatment program in Indian Brook watershed. The principal problems arise from the lack of adequate financial and technical assistance to plan and apply the needed land treatment measures.

Erosion and water management problems from changed land use continue to develop in the watershed. Urban use creates higher runoff from the watershed, increasing the erosion and sedimentation rates. Planning boards and community leaders need planning assistance to promote development in an orderly manner while maintaining environmental quality. Accelerated erosion, which might result from development must be contained by treatment measures such as plantings in critical areas, sediment trapping areas, debris basins and forest buffer zones. Currently, erosion is not a problem on agricultural and forest lands.

The woodlands in the watershed are in small individual holdings. Planning for sustained yields and improved growth and quality is difficult and typically neglected on these holdings in favor of short-term gains. Profits are generally small and best use of these resources is not often realized. As small holdings make up 25 percent of the total commercial timberland in Coos County, their proper management is important to the future of the county's forest-based industry. As the timber matures on the forest land within the watershed, access into the area will be necessary for harvest operations. To minimize erosion there is a need for proper layout and installation of skid trails and access roads.

Land treatment measures such as pastureland and hayland management and planting, drainage mains and laterals, and grassed waterways are needed on the cropland to sustain and improve production.

Recreation practices such as roads and trails are needed for access to the forest land. Wildlife improvement practices are needed to improve wildlife habitat. Technical assistance is needed to help the landowners institute measures such as wildlife habitat management, wildlife wetland management, recreation area improvement, and recreation trails and walkways.

Floodwater Damage

The major water resources problem in the watershed is urban flooding in Lancaster. Damages occur frequently to buildings, houses and grounds in the flood plain both from overland flooding and seepage from the high water table. Damages also occur to roads as a result of bank erosion and overtopping and washing out of culverts. Agricultural damages, limited primarily to hayland, are delayed harvest, loss of fertilizer and deposition of silt and debris on hayland and harvestable hay.

The threat of flooding exists every spring when rapid snowmelt is accompanied by spring rains. As a result, flooding has occurred in 14 of the last 46 years and most recently in 1967, 1972 and 1973.

The problem of high flows is compounded by low channel capacity, inadequate bridge openings and a broad, flat flood plain. High flows quickly overtop streambanks and spread over the flood plain. However, water damage is not limited to periods of overland flow. Increased stages in Indian Brook raise the level of the water table, resulting in increased basement floodings from seepage.

The severity of flooding varies with the magnitude and frequency of each storm. For the 100-year frequency storm, flooding from Indian Brook affects about 50 acres of flood plain which includes 5 acres of hayland, about 14 residences, and 16 mobile homes (see figure 3). The depth of flooding in the urban area from the 100-year storm is 3 to 4 feet. Flood stages at Summer Street are 1 foot over the road surface and more than 2 feet over the culvert opening. At Depot Street, stages are about 2 feet over the top of the road and more than 3 feet over the top of the culvert opening.

Flood damages are minimal for the annual storm but increase rapidly for the 5 to 10-year and less frequent storms. For the 100-year frequency storm, damages in excess of \$110,000 can be expected. The average annual flood damage is \$11,130 of which \$10,700, or 96.1 percent, is to urban property, \$400, or 3.6 percent to roads and bridges, and \$30, or 0.3 percent, to agricultural lands. Indirect damages are estimated to be \$1,700. (See figure 3 for location of the flood plain damage area.)

While the 5 acres of hayland now in the flood-prone area is limited in use because of the flood hazard, this land is valued at several hundred dollars per acre because of its proximity to developed land. Typical house values in Lancaster are in the \$16,000 to \$20,000 range for older three- or four-bedroom homes. However, many of the homes in the flood plain reflect substandard conditions and have less value. Many of the residences in the flood plain are mobile homes which are valued from \$6,000 to \$8,000 each.

Floodwater damages were determined for three evaluation reaches: the Sand Road-Causeway Street area, the area between the Boston and Maine Railroad and Summer Street, and the mobile home park located between Depot and Summer Streets. Additional damages occur to residences and three commercial establishments in downstream reaches which are on a flood plain common with the Connecticut River. Since most of the flooding in this area originates from the river, these reaches were not included in the study. Agricultural damages also occur in this common flood plain.

The mobile homes and residences in the flood plain have individual septic systems, which are subject to flooding. These septic systems become inoperative during periods of overland flooding and high water table. Water pollution and health problems result.

Erosion and Sediment Damage

There are no critical erosion areas which create a sediment problem. The most serious erosion problem occurs in the Lancaster urban area along roads in residential areas. Some erosion takes place when floodwaters overtop the roads. When this occurs, the road berms must be repaired. Eight to 24 tons of gravel are needed every 3 to 5 years to make these repairs.

The annual soil loss rate from sheet erosion is estimated at 0.25 tons per acre for the woodland, hayland and pasture areas of the watershed. This soil loss rate approaches the minimum attainable. An annual rate of 2 tons per acre is estimated for the urban area, and it is associated mainly with roads and new development. Based on the above rates of erosion and a 30-percent delivery rate for forest land and pasture and hay land and 50-percent delivery rate for urban land, the estimated sediment load delivered to the mouth of Indian Brook is 158 tons per year or 0.11 ton per acre per year. The average concentration of sediment in the water over a one-year period is about 50 ppm.

Sediment damage is generally so slight that it is not measurable. The primary damage results when debris, gathered by floodwater as it flows across the flat peat and muck soils in the upper watershed, is deposited in the lower developed areas.

Fish and Wildlife

The Indian Brook watershed is located in a region rich in fish and wildlife species and habitat. These resources are of extreme importance, since they are one of the major tourist attractions. The area is strongly dependent on tourism for its livelihood. Improved highway systems along with increases in the mobility of people and more leisure time have created a rapidly-growing demand on fish and wildlife species and their habitat.

The U. S. Department of the Interior has compiled supply and demand figures for fishing in the northern New Hampshire portion of the Connecticut River Basin. The area of Indian Brook is included in this report. The resources of the area can now support 520,000 fisherman days of use. Current use in the area is 294,000 fisherman days. Future demands are expected to reach 506,000 fisherman days by 1980 and 910,000 days by 2020. Through pollution abatement and increased public access, the present resource has the potential to meet 951,000 fisherman days. This will meet all 1980 demands and the overall 2020 demand; however, in 2020 the projected demand for cold water fishing will surpass the supply by 99,000 fisherman days.

Hunting will increase in the future. Despite slight decreases in projected per capita participation rates (12 percent by 2000 according to Outdoor Recreation Review Commission Study Report 26), population increases will still increase the demand. With the loss of habitat to development, especially around urban areas, the remaining habitat must absorb the additional pressure.

Hunting pressure for deer in the Lancaster vicinity is heavy. Good habitat and populations of eight deer per square mile of habitat are attractions to hunters. Early snows in this northern area usually provide excellent hunting conditions. As a result, the deer take rate is 1.52 per square mile, one of the highest in the State. Maintenance of habitat is therefore essential if the deer herd is to be maintained in light of hunting demands.

Public access is generally available to much of the land under the current management policies of the White Mountain National Forest and the major private landholders. However, demands on land for urban needs, recreation areas, and second-home developments are growing. Since most of the land is presently available for wildlife habitat, each new demand removes a portion of the present habitat.

In addition, demands for nature study and conservation education areas have increased over the past few years. The conservation of existing habitat and development of new areas for fish and wildlife is of prime importance to this region. Acquisition of fish and wildlife habitat areas is needed to meet demands for public access to fish and wildlife resources, whether they be consumptive or nonconsumptive.

Recreation

Within the entire region, problems associated with recreation are similar to those associated with fish and wildlife. These are discussed in the Fish and Wildlife Resource Problem section. The recreation resources of the area are plentiful, attractive and in use. With the construction of two interstate highways, I-93 and I-91, the region has become more accessible to urban population centers. The natural resources are under increasing pressure because of their attractiveness, a trend which is expected to continue.

The recreation industry is an important part of the region's economy, and there is a need to protect recreation resources through proper planning of water and related land resource uses.

Economic and Social

The economy of the area needs stimulation. The lack of employment opportunity is reflected by high unemployment and underemployment rates. Reports by the New Hampshire Department of Employment Security indicate a 15 percent decrease in covered employment since 1955.

The median income for families in Coos County is \$8,137, and in Lancaster, \$7,967. This is less than the \$9,698 average for the state. This is further complicated by the higher prices for many consumer goods resulting from the area's remoteness from major markets.

The lack of employment opportunities in the area has resulted in an out-migration, particularly among those in the 15 to 29 and 1 to 4 year age groups. Young adults, many with children, are leaving the area to find employment elsewhere. This has significantly changed the shape of the population pyramid.

Programs under the Public Works and Economic Development Act of 1965 and the North Country Resource Conservation and Development Project have been initiated to improve the overall economy of the region.

Water Qualities Problems

Effluents from the inoperative septic tanks of individual residences pollute streams during floods and wet periods. However, the Lancaster sewage treatment facility has been expanded and collection mains extend into the area. As an increasing number of residences are served by the municipal system, pollution in the stream will decrease. The town will require any new development in the service area to tie into the sewerage treatment system.

PROJECTS OF OTHER AGENCIES

The Town of Lancaster has been active in developing a flood management plan for the town. Two programs involve the Indian Brook watershed.

The Town has requested and received a flood hazard analysis for the Connecticut River flood plain and its tributaries including Indian Brook. This study, carried out through the New Hampshire Office of Comprehensive Planning with technical assistance provided by the Soil Conservation Service, will provide the technical information needed to implement a plan for flood plain use and management.

In April of 1973, the Town of Lancaster was accepted as a participant in the regular program of the HUD National Flood Insurance Program. Flood plain residences and businesses are therefore eligible for flood insurance. The Town is now in the process of formulating its regulations as required by that program to minimize future damages from development in flood prone areas.

Together these programs will complement the flood prevention works of this plan in the Town's efforts toward sound and sensible flood management.

PROJECT FORMULATION

In 1956, an initial watershed application was submitted for the combined Otter, Garland and Indian Brook watershed. The original objectives were to improve drainage and brook fisheries. Planning action was deferred.

In July 1966, the Town of Lancaster Board of Selectmen initiated an amended application which included only the Indian Brook portion of the watershed. The sponsors, the Town of Lancaster, the New Hampshire Water Resources Board and the Coos County Conservation District held several meetings to develop objectives and to formulate a plan for works of improvement. Two public information meetings were held in 1970 to review planning progress. One was held in conjunction with the Town's annual budget hearing. Since that time the plan has been altered to withdraw recreation as a purpose and to incorporate fish and wildlife management. The New Hampshire Fish and Game Department became a sponsor.

The U. S. Fish and Wildlife Service prepared a report which recommended fish and wildlife measures to be included in the plan. Semi-annual meetings held by the Fish and Game Department, the U. S. Fish and Wildlife Service and the Soil Conservation Service have been used to coordinate and formulate fish and wildlife objectives in the watershed.

Implementation of a watershed project in Indian Brook has been recommended in the Connecticut River Basin Comprehensive Water and Related Land Resource Investigation, completed in 1970, and by the New England River Basins Commission 1980 Connecticut River Basin Plan, completed in 1972. One of the principal motives of the Connecticut River Basin Plan was to propose economically and environmentally sound uses for the natural resources of the basin. This watershed plan complies with these objectives through prevention of flood damages, development of fish and wildlife habitat, and provisions for good land management.

This watershed project is also listed as a proposed measure in the North Country Resource Conservation and Development Project Plan. Similar to the above, the North Country RC&D project objective is: "To develop and use the area's resources for the economic good of all its citizens and... maintain the... natural resource heritage." This plan for the Indian Brook watershed has been formulated in accordance with these objectives.

Objectives

When the application was amended to include only Indian Brook watershed, the sponsors reconsidered their objectives in terms of the needs of the new watershed area. The revised objectives, which were agreed upon as a basis for project formulation, are as follows:

1. During a 5-year accelerated land treatment program, install measures on the land to improve hydrologic conditions in the watershed in order that peak runoffs will be reduced; minimize erosion and sediment from forest land, pasture and hay land; and keep soil losses within allowable limits for the urban area in view of possible accelerated erosion from development.

Develop management plans and land treatment for all lands needing treatment within the watershed.

2. Eliminate floodwater damage from the 100-year frequency storm in the Indian Brook urban flood plain area of Lancaster.
3. Provide multiple-use in a floodwater retarding structure by including a marsh development for protecting and improving fish and wildlife habitat.
4. Initiate land use planning that is compatible with the Town Plan.^{1/}
5. Protect and improve existing fish and wildlife resources.

Environmental Considerations

Any project in the Indian Brook watershed that meets the objectives of the sponsors has the potential of altering present environmental conditions. The reduction of both flood damages and erosion and the improvement of fish and wildlife habitat represent changes. With flood protection provided, more intensive development of the flood plain in the urban area is likely to occur. This area is close to the business district of Lancaster, has municipal water and sewer services, and is adjacent to major transportation and utility networks. However, during the project formulation stage, attempts were made to minimize those impacts which were felt to be adverse.

Also during the plan formulation stage, recreational and fish and wildlife needs were considered in the watershed streams and impounding sites. The sponsors and other participating agencies after hearing the opinions of the public, formulated the project as proposed. During the early planning stage, one multiple-purpose, 120-acre site was considered for recreation and floodwater storage. During reviews with the sponsors and the public, recreation was dropped as a purpose. The water in the brook is colored from the organic material in the marshes along the brook and thus the site becomes undesirable for recreational uses such as swimming. Fish and wildlife was added as a purpose.

A fish and wildlife marsh development was selected as a purpose along with flood prevention at site 1. A second structure at site 2 was selected as a single-purpose, flood prevention structure to provide additional flood prevention in combination with other planned measures.

The proposed reservoir structures were designed to minimize adverse impacts on the marshes, a deer yard, and woodland wildlife habitat. To maintain and enhance the marsh for wildlife, site 1 was designed to include a shallow permanent pool. The crest elevation for the emergency

^{1/} William Dickson Associates, Inc., Lancaster, New Hampshire Town Plan, 1970.

spillway at this site as established will prevent floodwater stored in the structure from reaching an adjacent deeryard. At site 2, the crest elevation of the principal spillway is designed to maintain the water level established by an old beaver pond.

Maintenance, protection and conservation of the marshland and adjacent woodland at site 1 are of local concern. Additional land will be acquired in fee title; and an access road, parking lot and boat ramp will be installed. The land and facilities will provide a buffer zone to protect the area against encroaching development while providing for public access, management, and conservation.

Although the level of use anticipated at site 1 does not necessitate the installation of sanitary facilities, the plan provides for the monitoring of water quality and sanitary conditions. The sponsors agree to install sanitary facilities should they become necessary.

The proposed single-purpose, flood prevention structure at site 2 will not provide additional recreational or fish and wildlife opportunities. Public access will not be provided.

About 170 acres, 45 acres of marshland and 125 acres of forest land, will be required for installation of the two structures. Thirty acres of forest land at the upper site will be converted to marshland for a total marshland area of 52 acres. The area of marshland will not increase at site 2. The dam, spillway and construction areas will convert 17 acres of forest land to open grassland.

To preclude unacceptable erosion during channel installation, a pilot channel will be constructed to lower the water table in the adjacent flood plain. A sediment trap at the lower end of the proposed work will catch the initial sediment. To control sediment during finished construction, spoil spreading and excavation will proceed simultaneously with temporary seeding of the disturbed areas at the end of each day's work.

About 75 percent of the meandering natural channel is lined with small brush and young sapling trees less than 2 inches in diameter. The present channel occupies about one-half acre, and the adjacent vegetation occupies an additional acre. After installation of the project, the channel and spoil area will occupy about 7 acres. The channel and spoil areas will be seeded and planted to appropriate grasses, shrubs and tree seedlings.

In the urban area there are environmental concerns with flooding, erosion, and sediment deposition on the flood plain. The project selected meets the stated objective of reducing damages from these hazards without inducing downstream damages.

Flood plain areas (17 acres) interspersed with and immediately adjacent to the present urban area are expected to undergo development after installation of the project. In view of local plans, investments in utilities, roads and other service items in this area and the suitability,

developmental costs and environmental impacts for development at other sites, this expected additional development was considered acceptable.

The selected plan will not necessitate the displacement of people, businesses or farm operations.

Alternatives

A number of possible alternatives have been considered. They can be grouped into the following categories: Land treatment alone, land use controls and flood insurance; floodproofing; relocation of existing buildings; land use controls, floodproofing and relocation; fish and wildlife development; channel work alone; floodwater retarding structures; channel work and multiple-purpose structure; and no project. A discussion of each of the alternatives considered follows:

Land Treatment Alone: This alternative would provide technical assistance to keep conservation and woodland management plans up to date, to develop new plans as landownership or land use changes, to maintain existing adequate cover and maintain installed land treatment measures, to plan and implement applicable treatment measures on land requiring treatment and to complete soil surveys and resource inventories. Technical assistance would also be provided to the Town of Lancaster, regional planning agencies, developers and others in planning urban development which is consistent with environmental quality.

Additional land treatment measures would be applied to treat adequately all the lands of the watershed. Measures which would be applied to pasture and hay land include pasture and hay land planting and management, drainage mains and laterals, and grassed waterways on the cropland. Forest land measures which would be applied are harvest cutting, skid trails, access road location and stabilization, recreation area improvement, recreation trails and walkways, and wildlife habitat management. Measures which would be installed in the urban area include sediment trapping areas, debris basins and forest buffer zones. This alternative plan would be similar to the land treatment phase of the planned project.

The cost of the land treatment plan would be about \$80,700.

This alternative would improve the hydrologic condition of the watershed, reduce flood flows by about 5 percent and provide a limited amount of fish and wildlife and recreation opportunity. Opportunities for systematic development would be improved through the availability of technical assistance to local planning boards and community leaders to help guide planned urban development and the maintenance of environmental quality.

This plan would meet the selected objectives of the sponsors for a land treatment program. However, the plan would not provide flood protection from the 100-year frequency flood nor would it lower the water table in the urban flood plain. There would be no provision for the improvement and protection of fish and wildlife habitat.

If this alternative were implemented, some of the adverse environmental effects of the planned project would be avoided. These are: (1) the loss of stream reach due to flooding by the proposed pool; (2) the loss of 30 acres of forest land to the marsh; (3) disturbance of any fish life and related food chain in the reach of channel work; (4) disruption of traffic to install culverts at Summer and Depot Streets; (5) the commitment of 177 acres of land to the planned project; (6) the temporary effects of noise, water and air pollution and accelerated erosion resulting from the construction activity; and (7) people and vehicular traffic coming into the fish and wildlife development area.

Land Use Controls and Flood Insurance: In April 1973, the Town of Lancaster received approval to participate in the National Flood Insurance Program, which is administered by the Department of Housing and Urban Development. In order to retain eligibility in the program, the Town must adopt flood plain zoning ordinances. The Soil Conservation Service has prepared maps delineating the flood hazard zones and provided them to the Town. The estimated annual cost for insurance premiums would be about \$6,500, of which about \$650 would be local cost. The present worth of this cost over 100 years at 5-7/8 percent is \$110,000. An additional \$5,000 would be needed for town planning services to implement land use controls.

This alternative would reimburse participating landowners for financial loss from flood damages according to the guidelines of the insurance program.

Through the imposed land use controls, future development on the flood plain would be restricted. Existing development on the flood plain would remain essentially intact.

The insurance payments for flood damages incurred by participants in the program would provide reimbursement for property and household items damaged. However, payments would not be adequate, either to replace totally items destroyed or damaged, or to provide for such related items as cleanup, inconvenience and other indirect damages. This alternative does not eliminate the 100-year flood nor does it lower the water table in the urban flood plain of Indian Brook. There would be no significant provision for improvement and protection of fish and wildlife habitat.

This alternative would avoid the same adverse environmental effects as the "Land Treatment Alone" option.

Floodproofing: This alternative would require the floodproofing of the 16 mobile homes and 14 residences that are located on the flood plain. Each residence and mobile home would be altered in such a way that property damage would not occur for the selected design flood (probably the 100-year frequency flood). In some cases, it might be necessary to raise the mobile home to an elevation above the flooding. In the case of permanent buildings, the installation of structural and other works could be needed to provide adequate protection. Any new development on the flood plain could be protected from flooding by building the structure at an elevation above the selected design flood and with sufficient structural integrity to withstand expected flows.

The cost to floodproof the buildings and mobile homes now located on Indian Brook flood plain would be about \$80,000.

Floodproofing would reduce floodwater damage by protecting existing buildings on the flood plain from floods up to and including the selected design flood.

This alternative would not eliminate the 100-year flood from the flood plain nor would it lower the water table. Damages to roads and culverts would continue. There would be no provision for fish and wildlife habitat protection and improvement.

As in the case of the "Land Use Controls and Flood Insurance" alternative, this plan would avoid the same adverse environmental factors as the "Land Treatment Alone" option.

Relocation of Existing Buildings: Thirty families would be relocated out of the flood plain. The existing residences would be moved to areas where flooding is not a problem. The 16 mobile homes could be moved easily. In the case of the 14 permanent residences, some of the houses might be moved while others would have to be replaced. New septic systems and other services would be required. Existing development on the flood plain occupies about 13 acres. The abandoned area could be used as open space and land use controls would be placed on its future use so that no new development would take place.

The cost to relocate the 30 families into nearby areas outside the flood plain would be about \$660,000. This includes the cost to move each family, the mobile homes and permanent houses that are movable, to purchase the flood plain land and the land outside the flood plain on which to relocate, and to provide the necessary services.

If such an alternative were implemented, the flood hazard associated with the flood plain would be reduced. The flood plain area would then become available for open space or some other use compatible with the flooding problem.

This alternative plan would have a social impact on 30 families by moving them from one location to another and would create a severe hardship in some cases.

The relocation of 30 residences out of the flood plain at one time would create an impact in other areas of the town. The availability of adequate residential space within the existing service areas of town facilities is unlikely. This will result in the necessity of extending the service areas into immediately surrounding areas or forcing relocations to random scattered areas; the result would be urban sprawl.

The flooding and high water table in the flood plain would still exist; however, the use of the area would have changed so that floodwater damages would not be significant. Damage to roads and culverts would continue and travel would be interrupted during periods of flooding.

As with the other alternatives given, this option would avoid the same adverse environmental effects as the "Land Treatment Alone" plan.

Land Use Controls, Floodproofing and Relocation: This alternative is a combination of the three options discussed singly above. The combination offers flexibility in comparing and selecting the single alternative which seems most practical to solve a problem of flood plain management. The 16 homes in the mobile home park could be relocated with relative ease. The remaining 14 permanent residences would be floodproofed for a selected design flood. (In this case, a 100-year frequency flood was used for estimating cost.) Land use controls could be adopted to prevent future development.

This alternative would cost about \$214,000.

Essentially, this alternative would eliminate floodwater damages from overland flooding to those houses still remaining in the flood plain.

The basements of the homes remaining in the flood plain would be protected from the existing high water table. Land in the flood plain would become available for other, less intensive, uses.

As discussed under "Relocation of Existing Buildings", the relocation of the 16 families living in mobile homes would create hardships. Utilization of the necessary land to relocate the mobile homes would create an additional impact on the towns. Construction activities to floodproof the homes remaining in the flood plain would create brief disruptions. Flooding of the roads in the flood plain would continue to be a traffic hazard. Land use controls would restrict the use of the land in the flood plain.

This alternative would not relieve the high water table or reduce the level of flooding on the flood plain.

The adverse environmental effects of the planned project which would be avoided if this alternative were implemented would be the same as those listed under the "Land Treatment Alone" alternative.

Fish and Wildlife Development (Single-Purpose): A single-purpose fish and wildlife development could be built at either site 1 or site 2 for enhancement, preservation and protection of fish and wildlife habitat in the area. The size of the pool at either site could vary from just a few acres to 100 acres. The dam could be built with a water level control feature to manage the habitat more effectively than the natural controls that presently exist. A small service area, including parking and a boat ramp, could provide access for public use.

A 50-acre marsh development at site 1 with facilities for public use would cost about \$98,000. A 20-acre development at site 2 for public use would cost \$90,000.

A development at either site would provide improved fish and wildlife habitat. It will also provide for public access into a wildlife area that people could enjoy.

Such a project would permanently flood about 3,600 feet of stream. Up to 30 acres of fir and spruce forest land would be lost including its availability as upland game habitat. Up to about 140 acres of land would be committed to the project. There would be noise, water and air pollution and accelerated erosion during construction activity. The project would open the area to more people and vehicular traffic. Accelerated erosion during construction would contribute greater amounts of sediment downstream.

This alternative would not meet the sponsors' objective to provide a 100-year level of flood protection in the urban area nor would it reduce the water table level in the flood plain.

If this alternative were implemented, major disturbance of fish life and related food chain in the reach of the proposed channel work and disruption of traffic to install culverts at Summer and Depot Streets would be avoided.

Channel Work Alone: This alternative involves about 3,000 feet of channel work in the urban flood plain. A grade stabilization structure would be located at the upper end of the proposed channel work to drop the streamflow from the natural stream into the constructed channel without creating an erosion problem. The channel would be about 30 feet wide and 7 feet deep and would carry the flow from a 100-year frequency flood.

The cost of channel work alone would be about \$130,000.

This alternative would meet the sponsors' objectives to provide 100-year level flood protection and lower the water table in the flood plain thus reducing flood damages to the property owners.

The 3,000 feet of channel work would disturb the fish life and related food chain during and following construction. Disruptions caused by construction activity in replacing culverts at Summer and Depot Streets would necessitate the rerouting of traffic. There would be noise, water and air pollution and accelerated erosion during construction activity. The proposed channel work would induce higher peak flows downstream.

This alternative does not include an accelerated land treatment program, the protection and improvement of existing fish and wildlife resources, a fish and wildlife marsh development or land use planning.

Some of the adverse environmental effects of the planned project which would be avoided if this alternative were implemented would be (1) the loss of stream reach due to flooding by the proposed structure at site 1; (2) the loss of 30 acres of forest land to the marsh; (3) the commitment of about 170 acres of land to the planned project; and (4) people and vehicular traffic coming into the fish and wildlife development area.

Floodwater Retarding Structures: In this alternative, two reservoir structures would be located at sites 1 and 2. They would be essentially the same size as those included in the planned project, and the dam and spillways at site 2 would be the same. The dam at site 1 would be about 1 foot lower without any fish and wildlife water stored in the pool.

The cost would be about \$66,000 for structure 1 and \$58,000 for structure 2, or \$124,000 for the two.

The structures would provide some flood protection to the urban flood plain, but the level would be inadequate to meet the sponsors' objectives for flood protection.

About 90 acres of land would be committed to this alternative. There would be noise, water and air pollution and accelerated erosion during construction activities.

This plan would not include land treatment, the protection and improvement of existing fish and wildlife resources, a fish and wildlife marsh development or land use planning.

Adverse environmental effects of the planned project which could be avoided, if this alternative were implemented, would be (1) disturbance of the fish life and related food chain in the reach of proposed channel work; (2) disruption of traffic to install culverts at Summer and Depot Streets; and (3) people and vehicular traffic coming into the fish and wildlife development area.

Channel Work and a Multiple-Purpose Structure: The multiple-purpose structure would be located at site 2. A 120-acre lake would be available for recreation and fish and wildlife purposes. The lake would be deep enough to provide a cold water fishery. The channel work would be approximately 3,000 feet in length with a grade stabilization structure located at the upper end. The depth of the channel would be 6 to 7 feet and the bottom width would be 6 feet; the top width would range from 24 to 27 feet.

The cost to install the structural measures planned in this alternative would be \$480,000.

This alternative would provide flood protection from the 100-year storm to 30 acres in the urban flood plain, including 30 residences. The ground water table would be lowered. Recreation and fishing opportunities would be available at the lake. Land in the flood plain near town sewerage and water would be available for development. The dam and spillway would be seeded to grasses and legumes and would provide open areas of food and cover for wildlife.

About 250 acres of forest land, including game habitat to be replaced, would be taken for the proposed lake. The channel work in the urban area would disturb the fish life and related food chain during and for about a year following construction. Traffic on Summer and Depot Streets

would be disrupted while culverts were replaced. About 300 acres of land would be committed to the project. Noise, water and air pollution and accelerated erosion might occur as a result of the construction activity. The area at the multiple-purpose site would be available to people and vehicular traffic.

This alternative does not include an accelerated land treatment program, the protection and improvement of existing fish and wildlife resources, or land use planning.

This alternative would avert none of the adverse effects of the planned project with the exception of the commitment of some of the land around site 1.

No Project: If no project is considered, there would be no concerted activity directed toward solving the water and related land resource problems that exist in the watershed. The existing conditions in the watershed are discussed in the Environmental Setting section.

At present there is an on-going land treatment program in Coos County. Part of this effort is applied to the lands in the watershed. This activity could be expected to continue at its present rate. About \$6,700 is spent each year in the watershed to carry out the on-going land treatment program. This includes both the cost of installing the treatment measures and the cost of technical assistance.

If no project is considered for the watershed, the floodwater damage problems the sponsors are trying to solve would remain. Net annual monetary benefits of \$6,030 would be foregone.

The accelerated land treatment program, elimination of floodwater damages, provisions for a fish and wildlife marsh, land use planning, and protection and improvement of existing fish and wildlife resources would not be considered in an overall planning and implementation effort.

All of the adverse environmental effects of the planned project would be avoided if this alternative were selected.

Selection of the Planned Project

A program including land treatment, 3,000 feet of channel work, a floodwater retarding structure and a multiple-purpose reservoir was selected to meet the objectives of the sponsors. The planned land treatment program will help hold erosion rates to 0.25 ton per acre per year on woodlands and agricultural land without impeding timber and crop harvests. Reducing erosion rates to acceptable limits in the urban area will be important if the expected development takes place. A program of technical assistance will help guide the good management policies and operational practices essential to achieving the objectives.

The structural measures will complement each other in preventing 100-year flood damage in the urban area. The dams will reduce the volume of floodwater to such an extent that flood damages in the urban area can be prevented with minimal channel enlargement. Channel capacity will not increase enough to induce flood damage downstream. The reservoir sites will provide additional fish and wildlife habitat in the watershed.

WORKS OF IMPROVEMENT TO BE INSTALLED

The watershed project consists of land treatment, a multiple-purpose dam for flood protection and fish and wildlife habitat development, a floodwater retarding structure, fish and wildlife facilities, and about 3,000 feet of channel work. (See project map, figure 4). A detailed description of the planned project follows.

Land Treatment

The land treatment phase of the plan applies to each acre in the watershed. Landowners and operators will be encouraged to manage and operate their lands to maintain the adequate cover and treatment measures now on the ground. They will also be encouraged to install conservation measures to meet problems in the watershed. The landowners will install these measures dependent upon their individual interests, their means to do so, and applicable State and local laws.

The Coos County Conservation District and state and federal agencies will take such actions as needed to inform the public of technical and financial assistance available to assist them in necessary and proper land treatment.

Technical assistance will be provided to landowners to develop new conservation and woodland management plans and to revise existing plans as necessary. Technical assistance will also be available to landowners for the installation of conservation measures which are set forth in their plans. In addition, technical assistance will also be provided to the Town, regional planning agencies, developers and others in planning land use changes in a manner consistent with environmental quality. The Soil Conservation Service will develop detailed soil surveys as needed in all phases of planning.

Through consensus of the Conservation District, community leaders, landowners, and state and federal agencies, it was agreed that essential land treatment should be applied to 1,125 acres of forest land, 15 acres of hay and pasture land, 50 acres of land expected to undergo urban development, and 105 acres of miscellaneous land.

Forest land treatment measures, to be installed on 1,125 acres, will be proper harvest cutting, skid trails and access road location and stabilization, recreation area improvement, recreation trails and walkways, wildlife habitat management and fire protection.

Land treatment measures to be applied to the 15 acres of pasture and hay land will include grassland planting and management, drainage mains and laterals, and grassed waterways.

Land treatment measures to be applied to the 50 acres of the urban area include critical area planting, sediment trapping areas, debris basins, forest buffer zones, and the preservation of appropriate natural areas.

Measures planned for 105 acres of other land are concentrated primarily in the open marshes and along roadways and include mulching of road cuts and wildlife wetland management.

The time required to install the land treatment measures is 5 years.

Structural Measures

The structural measures are shown on the project map, figure 4. They include one single-purpose floodwater retarding structure, one multiple-purpose dam for flood protection and fish and wildlife habitat development, fish and wildlife facilities, and about 3,000 feet of channel work including a grade stabilization structure. The two reservoirs are located in series on Indian Brook in the upland portion of the watershed and will control about 1.45 square miles or about 65 percent of the drainage area.

The two reservoir structures are designed to control the runoff from a 100-year frequency storm with reserve capacity to handle floodwaters from greater storms than the 100-year. The principal spillway designed release rate for the 100-year storm is 88 cubic feet per second at site 1 and is 103 cubic feet per second at site 2. The designed life of the structures is 100 years.

At site 1, the multiple-purpose structure will control about 1.11 square miles of drainage area. The reservoir will provide 176 acre-feet of temporary floodwater storage, 116 acre-feet of water for fish and wildlife habitat and 4 acre-feet for sediment. The designed capacity for sediment storage from the contributing watershed area is equivalent to a rate of 0.0007 inch per year, or 56 tons per year for the 100-year designed life. The beneficial pool, with a surface area of about 52 acres and an average depth of about 2 feet, will be a permanent wildlife marsh.

At site 2, downstream from site 1, a single-purpose floodwater retarding structure will control an additional 0.34 square mile of drainage area. The site will provide 47 acre-feet of temporary storage for floodwater and 1.5 acre-feet for sediment. The volume of sediment to be stored is equivalent to a rate of 0.0008 inch per year, or 21 tons per year from the contributing watershed area for the 100-year designed life. The principal spillway crest at site 2 is planned to maintain the same pool elevation as presently provided by an inactive beaver dam. Sediment accumulation will be stored below this level.

The dams will be built of relatively impervious homogeneous earth fill of glacial till origin and will be placed on rock and glacial till foundations. Excavated material from the emergency spillway at site 2 will provide the fill material needed at both sites. Principal spillways at both sites will be reinforced concrete, type C, straight drop spillways and will be supplemented by vegetated emergency spillways. Figure 1 illustrates the type of principal spillway to be used at site 1.

At site 1 the principal spillway is designed with a high and a low stage. Removable stop logs will permit water level control from a depth of 6 feet up to the low stage crest. This stop log crest will be 3 feet in length and 1 foot lower than the high stage. The high stage crest has an effective length of 10 feet and will extend as a concrete headwall on each end of the stop logs to the sidewalls of the spillway.

The same type spillway is planned at site 2 except that the principal spillway has one stage with a crest length of 6.5 feet. The crest of the stop logs will be at the same elevation as the crest of the concrete headwall on each end of the stop logs.

The water level of the beneficial pool at site 1 and the sediment pool at site 2 will be controlled at the principal spillway by the use of stop logs. The stop logs at site 1 will be used to regulate the water level on a schedule that will be most beneficial for wildlife habitat. The stop logs at both sites will be used for emptying the reservoir for future maintenance. Floodwater detention storage will be provided at both sites above the water level elevation controlled by the stop logs.

Geologic investigations have determined that the two low earth dams have bedrock and compact glacial till, respectively, in their foundations. The embankment design considers the use of mixed granular material for drainage. No active faults are known to exist at the sites. Earthquake risks of the proposed works are considered to be minor.

Public access will be provided at site 1 by acquiring additional land around the site. The water stored for fish and wildlife at the site is proposed mainly for wildlife habitat development and protection. The New Hampshire Fish and Game Department has facilities planned for the site which will allow use of the resource with a minimum of environmental disturbance. A boat launching area, access road and a parking area are planned with the idea of blending man's influences into the development as inconspicuously as possible (see figure 2). The Fish and Game Department feels that in view of the type of use anticipated for the fish and wildlife development, sanitary facilities will not be necessary. Water quality conditions will be monitored by the Fish and Game Department and if conditions warrant modification, the Department will install sanitary facilities. The access road to site 1 will utilize the bed of an abandoned logging railroad.

At site 2 potential exists for recreation and fish and wildlife use under present conditions. This includes a minor amount of hunting and nature observation. This potential will not be materially changed by the installation of the structure. In planning the project, the principals concluded that the potential for recreation and fish and wildlife use did not justify acquisition of land rights in fee title for public access to the site, nor the expense of monitoring to preclude development of unsanitary conditions and impairment of water quality. For these reasons, public access will not be available to site 2.

About 3,000 feet of channel work is proposed as an essential part of this plan to improve the water carrying capacity of Indian Brook through the Lancaster urban area. At present, Indian Brook in this area is a natural, perennial stream, except where modified by road and railroad crossings and in the vicinity of the mobile home park where about 550 feet of channel work was done by the Town of Lancaster in the fall of 1973. Flooding occurs frequently due to the low water carrying capacity of the present stream channel. In recent times flooding has occurred on an average of once in every 3 years.

The channel will be enlarged by excavation following closely the alignment of the existing channel. The work will start at the upper end of the urban area about 1,300 feet upstream from Summer Street and proceed downstream through the urban area to a point just above U. S. Route 3. At the upstream end of the channel work a grade stabilization structure will be installed. In the present damage area, 66-inch culverts will be used to replace the three street and two railroad conduits to pass the designed channel flow. Riprap will be placed around culverts where allowable velocities may be exceeded. The modified channel will have a bottom width of 6 feet, a depth of 6 to 7 feet, side slopes of 1.5 to 1 and a top width ranging from 24 to 27 feet.

The channel will be constructed in very loose, fine to coarse sand, muck, organic silt and silt. No bedrock is anticipated in this area. Because of the type of materials and the high water table, unstable side slopes are expected to exist for a short time after construction. Construction techniques, such as pilot channel excavation followed by excavation to approximate final channel cross section, will be used to reduce this problem.

The grade stabilization structure to be installed at the head of the channel work will drop the water about 6 feet and provide for channel installation on a nonerosive grade. The structure will be a reinforced concrete, type C, straight drop structure. The 11-foot weir provides for a flow of 165 cubic feet per second. It will be similar in appearance to the structure shown in figure 1, except that the concrete head-wall will be built without stop logs. The structure will be an "island-type", designed to pass the design flow through the drop spillway and fill the channel to bankful. Excess flows will pass around the structure in an emergency spillway at nonerosive velocities.

The capacity of the planned channel is sufficient to pass the 100-year storm within bank. The design discharge is based on the uncontrolled drainage area below the proposed reservoir sites plus the principal spillway discharge from the reservoirs. The reservoirs will provide sufficient floodwater storage to protect Lancaster when acting as a part of a system which includes the channel work. Downstream from the channel work, Indian Brook flows through a tree-lined channel within Connecticut River flood plain. As the brook is deeply entrenched, there will be no induced flood damages even though peak discharges from the 100-year storm will increase from 121 cfs to 191 cfs when the project is installed. (See figure 3 for the effects of flooding with and without project.)

Measures to control and minimize soil erosion, and water, air and noise pollution at the three construction sites will be included in the construction contracts. Construction areas will be revegetated promptly. Temporary culverts will be installed for construction equipment to cross the brook in the construction areas. A sediment trap will be installed below each construction site to catch initial sediment. To control sediment, channel excavation and spoil spreading will proceed simultaneously and temporary seeding of the disturbed areas will be done at the end of each day's work.

Dust will be kept within tolerable limits on haul roads. Pollution of surface areas or ground water by chemicals, fuel, lubricants, sewage and other pollutants will not be permitted. Clearing and disposal of brush and vegetation will be carried out in accordance with applicable laws, ordinances and regulations.

Requirements for safety and health in conformance with the Federal Construction Safety Act will be included in each construction contract. The design and construction of all measures will comply with applicable state water laws and regulations.

All construction areas devegetated and exposed will be graded to slopes suitable for revegetation and permanent seeding mixtures of grasses and legumes will be planted and mulched. Where consistent with planned functions, native shrubs will be planted on construction sites to provide protective cover and restore the areas to a natural setting.

Instituting the recommended measures in the Indian Brook watershed will not cause the displacement of any person, business or farm operation.

The time required to install the structural measures is 2 years.

The access road to sites 1 and 2 will follow the route of the old Kilkenny Railroad. Following construction, appropriate signing will call to the attention of visitors the existence and history of the railroad. In the vicinity of the sites the access road and a new trail will maintain the continuity of the trail system.

In the village area an existing granite split stone culvert on the Boston and Maine railroad spur will be removed when the channel is constructed. The existence of the culvert will be documented through drawings and description. If possible, the granite blocks will be salvaged.

The project actions involving the culvert and the railroad bed have been recommended by the historic preservation officer and historical consultant. If other archeological or historic values are uncovered or brought to the attention of the Soil Conservation Service during future investigations or construction, procedures in the Archeological and Historical Preservation Act (PL 93 291) will be followed. The New Hampshire Historic Preservation Officer and the Regional Director of the National Park Service in Philadelphia, Pennsylvania, will be notified. In addition the Regional Director of the National Park Service will be notified prior to the initiation of reservoir construction as required by PL 93 291.

The Soil Conservation Service will follow the requirements of Executive Order 11593, dealing with the protection and enhancement of the cultural environment.

Since this is a federally assisted local project there will be no change in the existing responsibilities of any federal agency with respect to archeological and historical resources. However, planning on this project has followed procedures, as instituted in consultation with the Advisory Council on Historic Preservation, to deal with nonfederally owned sites.

The development at site 1 will encompass about 140 acres, of which 22 acres is presently in shallow marsh and woodland. Water levels in the marsh are dependent on beaver activity which has been intermittent over the past few years. The marsh also supports mink, muskrat, and waterfowl. The surrounding woodland of hardwoods and conifers provide habitat for grouse, hare and deer.

With the project the 22 acres of marsh will remain undisturbed. Thirty acres of woodland will be inundated by the fish and wildlife pool and will combine with the 22 acres of existing marsh to make up a 52-acre shallow marsh. The habitat lost will affect mostly snowshoe hare. An additional 8 acres of woodland will be temporarily inundated by the flood pool. About 10 acres of woodland will be required for the construction of the dam, appurtenances and the adjoining work area. This will be maintained in a grass-legume vegetative cover following construction. The remaining 70 acres of woodland will be purchased as a protective buffer zone around, and for access to, the marsh. The entire 140 acres will be available for public use.

Thirty acres of land is required to install, operate and maintain the structure at site 2. Of this acreage, 7 acres is presently occupied by an abandoned beaver flowage, 7 acres is woodland and about 16 acres is marshland. The beaver flowage and marshland provide habitat for mink, muskrat and waterfowl while the woodland provides habitat primarily for hare and deer.

With construction of the project, the 7-acre beaver flowage will remain intact. The 7 acres of woodland will be cleared and used for the dam and its appurtenances and for temporary construction work areas. This area will be seeded to a permanent mixture of grasses and legumes following construction, providing food and habitat for deer, grouse, hare and ground nesting birds. The marshland will be within the floodwater detention pool and will therefore be temporarily flooded. Flowage easements will be obtained. Because of the limited potential for recreation and fish and wildlife use, public access at site 2 is not planned.

About 7 acres of perpetual easements will be needed for channel excavation, spoil spreading and access for operation and maintenance. The present channel occupies about one-half acre within this reach. The remainder of the area is made up of the sedge-bluejoint grass community and alder-willow and dogwood thickets. In the reach of channel work, present land use is almost equally divided among hayland, forest land and urban areas. Residential lawns border the stream in the mobile home park and along Summer

Street. Wildlife in the area consists primarily of songbirds, woodchucks, skunks, frogs, toads, and muskrats. No significant fishery has been found in the stream; minnows are the most abundant species.

After construction, the channel will occupy about 2 acres. The remainder of the area will be planted to grasses, shrubs and tree seedlings. No change in wildlife or fish species is expected.

EXPLANATION OF INSTALLATION COSTS

Cost estimates for technical assistance and application of land treatment measures are derived from recent expenditures for the installation of similar measures in the Coos County Conservation District. The total installation cost of the land treatment measures is \$80,700, \$14,100 for technical assistance and \$66,600 for application costs. Of the \$14,100 for technical assistance costs, \$1,900 will be furnished through the on-going land treatment programs available in the watershed. PL 566 funds will provide the remaining \$12,200 to the Soil Conservation Service and the U. S. Forest Service to accelerate technical assistance to landowners and operators and local governmental units. The \$66,600 estimated for application includes the cost of installing land treatment measures on private lands by landowners and operators and on public lands by the Town.

The estimated total structure installation cost is \$251,100: \$157,700 for construction, \$14,300 for engineering services, \$17,400 for project administration and \$61,700 for land rights.

Costs for structural measures are based on calculated quantities, estimates and unit costs for each construction item computed at 1975 prices. Unit costs for construction items are influenced by site conditions, quantities, and past bid prices for similar construction in the Northeast States. No unusual costs are anticipated during construction of the floodwater retarding structures; however, a contingency allowance of 12 percent has been added to the engineer's estimate to provide for unforeseen costs.

The very loose sandy material in the area of the proposed channel enlargement will quite possibly necessitate repair work during a three-year establishment period. Ten percent of the construction funding is budgeted for this probability. Further, 12 percent contingency allowance for unforeseen costs was added to the engineer's construction estimate.

Estimated construction costs of \$53,100 for the multiple-purpose structure at site 1 will be provided by PL 566 funds (\$42,700) and by other funds (\$10,400). The "Use of Facilities Method" was used to allocate joint costs for construction of the dam and its appurtenances. The flood prevention construction cost, representing 60.8 percent of the construction cost, is \$32,300; the fish and wildlife construction cost, representing 39.2 percent is \$20,800.

The estimated construction cost to install the fish and wildlife facilities at site 1 is \$20,000 and is a specific cost to the fish and wildlife purpose. PL 566 funds and other funds will each provide \$10,000.

PL 566 funds will bear the estimated construction costs of \$50,700 for the floodwater structure at site 2 and \$33,900 for the 3,000 feet of channel and grade stabilization structure. These amounts are allocated for flood prevention.

The engineering services cost of \$14,300 includes costs for surveys, geologic investigations, designs and preparation of plans and specifications. These costs are allocated in the same manner as the construction costs. PL 566 funds will bear costs of \$12,300 for structures 1 and 2, and channel work. Other funds will bear costs of \$2,000 for the fish and wildlife facilities at site 1.

The Service, with PL 566 funds, will bear the costs of project administration (\$14,800) which includes layout, inspection and administrative overhead. Project administration costs (\$2,600), including contract administration and other costs as incurred, will be provided by other funds. Project administration costs were not allocated to purpose.

The land rights cost associated with the multiple-purpose structure at site 1 is allocated as a specific cost to fish and wildlife purposes and is estimated to be \$9,000. About 70 acres will be purchased in fee simple title and includes areas required for the dam and its appurtenances, and the flowage area required for the design highwater as established by the routing of the emergency spillway hydrograph. The cost of the land rights will be shared equally by PL 566 and other funds.

The land rights cost associated with the fish and wildlife facilities at site 1 is also allocated as a specific cost to fish and wildlife purposes and is estimated to be \$9,500. Of this amount \$600 is for surveys, legal fees and other costs for the multiple-purpose structure and associated fish and wildlife facilities. About 70 acres, including 6 acres for the public access road, will be purchased in fee simple title. This cost will be borne totally by other funds.

Land rights costs for site 2 (\$3,100) and the channel work area (\$40,100) will be provided by other funds and are specific costs allocated to flood prevention. Approximately 30 acres will be secured for site 2 in either fee simple title or appropriate easement. Surveys, legal fees and other costs necessary to secure the land rights are estimated at \$600. Costs of channel land rights will consist of \$38,400 for enlargement of three road and two railroad culverts, \$1,100 for perpetual easements on about 7 acres of land for channel excavation and spoil deposition, and \$600 for surveys, legal fees and other costs. The easements will also provide access for future operation, maintenance and inspection.

Since the installation of the project measures recommended in this plan will not cause the relocation of any person, farm or business, no expenditures are necessary to meet relocation expenses.

The estimated schedule of total project funds for both land treatment and structural measures, for each year during the installation period is as follows:

<u>Year</u>	<u>Measure</u>	<u>PL 566 Funds</u>	<u>Other Funds</u>	<u>Total</u>
1	Land Treatment	\$2,500	\$14,000	\$16,500
2	Land Rights and Engineer- ing Design	12,600	18,800	31,400
	Land Treatment	2,500	14,000	16,500
3	Construction, structures 1 and 2 and channel design	107,400	13,600	121,000
	Land Treatment	2,500	14,000	16,500
4	Fish and Wildlife Facil- ities and channel work	48,900	49,800	98,700
	Land Treatment	2,500	13,500	16,000
5	Land Treatment	<u>2,200</u>	<u>13,000</u>	<u>15,200</u>
	Total	181,100	150,700	331,800

Actual costs to be borne by the Service from PL 566 funds and by the sponsors will be computed from the costs incurred in accordance with the cost sharing percentages shown in the agreement.

EFFECTS OF WORKS OF IMPROVEMENT

Upon implementation of the recommended measures of this project, certain effects and changes in the watershed area will be evident. Some of these changes will occur as a direct result of the measures and others will result as secondary or indirect effects.

Flood Prevention, Erosion and Sediment

Land treatment measures will maintain and improve the vegetative cover of the watershed on forest land, pasture and hay land, and in the urban area of Lancaster. The hydrologic condition of the watershed will be improved and the peak runoff will be reduced by about 5 percent.

Forest land treatment measures including proper harvest cutting and control of erosion from logging roads will maintain forest productivity and good hydrologic conditions. Proper location of new access roads and skid trails will minimize erosion during future harvesting. Planting, management and drainage measures will be applied to 15 acres of pasture and hay land to maintain productivity and provide vegetative cover. The present erosion rate of 0.25 ton of soil per acre per year is not expected to change. This rate is well below the acceptable limits for the cover and use of lands in the watershed.

In general, the planned measures will allow increased pasture and hay land and forest land production without causing excessive soil erosion or the destruction of recreation and wildlife potential in the watershed.

Planning assistance will help encourage land use changes consistent with the maintenance of environmental quality. Application of land treatment measures will prevent annual erosion rates from exceeding acceptable limits established for the area.

The structural measures, in combination, will reduce flooding in the urban flood plain. Channel work will increase the capacity of Indian Brook in the Summer Street area from 30 to 165 cubic feet per second. This increase in channel capacity, along with the retardation of flood flows by structures 1 and 2, will eliminate flooding on about 30 acres of flood plain area from storms up to and including the 100-year frequency storm (1 percent chance of occurrence). The protected flood plain includes the urban development in the Causeway Street, Sand Road, Summer Street and Depot Street area. In addition, forest land and hayland interspersed with and adjacent to the urban area near Causeway Street and Sand Road will be protected.

Geologic conditions in the flood plain indicate that ground water levels will be affected in the reach of channel work after construction. Along the present channel, the ground water level was found to be the same as the water level in the channel indicating a close relationship between the two. With the construction of the channel and grade stabilization structure, the channel bottom through the urban area will be about 7 feet lower than at present. As a result, during low flows the ground water levels adjacent to the channel will be lowered a like amount.

Estimates of drawdown effects indicate that drier basements will result at 30 residences within 500 feet of the channel, most significantly during low-flow conditions. Lowering the water table may affect the type of vegetation in the open areas. It may allow hardwood species and grasses to prevail rather than willows and sedges.

The project provides no protection for the area downstream from the channel work but neither will it create any induced damages downstream.

This reach is a brushy, deeply-entrenched arm of the Connecticut River flood plain. The floodwaters of the Connecticut cover this stream reach nearly every spring and negate any possible benefits from the Indian Brook project. The area above the grade stabilization structure is not protected from the 100-year storm by the reservoirs and will continue to be swampy with an undefined channel in some places. In the urban area, flooding will still occur from events which result in higher flows or stages than those associated with the 100-year storm.

Without the project, the discharge between the railroad and Summer Street in the event of a 500-year frequency flood would be about 150 cfs, producing a maximum flooding depth of 4.4 feet on the flood plain. With the project installed, the 500-year frequency flood would produce a discharge of 290 cfs with a maximum flooding depth of 2.6 feet.

Upon completion, the project will protect about 30 of the 50 acres subject to flooding from the 100-year storm. This includes about 13 acres of residential land and 17 acres of forest and hay land which is interspersed within present development. The recommended measures will benefit this urban area by reducing flood stages, which at times reach a depth of 3 to 4 feet along Indian Brook. Four farmers and 30 residential property owners will benefit from the flood protection. This will also increase the value of the 17 acres of forest and hay land. Present development patterns and pressures suggest that the land located in the Sand Road-Causeway Street area may be developed. Use of this area located near town water, sewer service, transportation and utilities will eliminate the expense and disruption of extending these utilities and services into other areas.

The additional development in this area of town will increase the demand on the public water supply and wastewater treatment facilities in the area. This will not overtax either system. Transmission and collection mains have just been extended into the area and carry excess capacity to meet expansion possibilities. The additional development could result in 140 persons to be served or loads of about .014 mgd on each system (based on 100 gallons per capita per day). According to the New Hampshire Public Water Supply Study, Phase One Report, the capacity of the Lancaster water supply system should be adequate until the year 2,000. The sewerage treatment system is designed to handle 4,000 persons and is presently serving about 2,000.

The erosion problems associated with floods below the 100-year frequency magnitude will be eliminated for homes, gardens, driveways and road shoulders in the urban area. Likewise, deposition of sediment and debris in the area will also be eliminated.

Erosion rates have been established at 2 tons per acre per year for the urban area and 0.25 ton per acre per year for forest land, and pasture and hay land. Under present conditions in the watershed, the annual sediment yield at the mouth of Indian Brook based on a 30-percent delivery rate for forest land, and pasture and hay land, and 50-percent delivery rate for the urban area is 158 tons or 0.11 ton per acre. During construction, the maximum annual yield will increase to 1,244 tons or 0.88 ton per acre. After the 2-year construction period and the reestablishment of vegetative cover, the sediment yield, including a projected increase in the urban area, will decrease to 155 tons or 0.11 ton per acre. The average concentration of sediment, which is 50 ppm at present, will increase to an annual average of 380 ppm during construction. The sediment concentrations will revert to present levels after completion of the construction phase of the project.

The two reservoir structures at sites 1 and 2 are designed to store 4.0 and 1.5 acre-feet of sediment respectively during the 100-year life of the project. This is sediment that would otherwise move downstream and impair water quality.

Fish and Wildlife and Recreation

The project will enlarge the marsh at site 1 from 22 to 52 acres. Site 1 will contain 116 acre-feet of water with an average depth of 2 feet. This marsh will be a Type 4 - inland deep fresh marsh. It will also exhibit characteristics of Type 3 - inland shallow fresh marshes, Type 5 - inland open fresh water marshes, and Type 6 - shrub swamps, which now exist. The area will be surrounded by a 70-acre buffer zone to ensure its protection and provide public access.

The fish and wildlife marsh and the buffer zone at site 1 comprise about 140 acres which will enhance the fish and wildlife habitat and population of the area. The New Hampshire Fish and Game Department will manage fish and wildlife maintenance, protection and propagation. The area will also provide a resting place for migratory waterfowl.

With a public access road provided to the marsh development, the resources of the watershed will become more available to the public. Parking facilities and a boat ramp will also be made available. Additional people and vehicular traffic will result. There is access to the area at present by way of an old logging railroad right-of-way. This is especially convenient and popular for snowmobilers in the winter. It is expected that 75 hunter days and 75 to 100 fisherman days will result from the project annually. Additional use is expected from the many persons who enjoy observing and photographing marsh wildlife.

Three beaver flowage areas and about 3,600 feet of stream channel will be flooded by the newly created marsh. At present, 3,000 feet is intermittently inundated by about 22 acres of beaver flowage. With the project, 30 acres of forest land, primarily in fir and spruce, will be flooded and become part of the marsh habitat. The trees in this area are expected to die, but will remain as a part of the marsh wildlife cover for about 10 years. The impact on the forest resources will be negligible. The loss of this 30 acres of upland game habitat will affect mostly snowshoe hare. As their range varies from 3 to 30 acres per hare, at normal population levels, habitat for about five or six animals would be lost. Water levels at site 1 will not interfere with deer yarding in the area. The deeryard is located above elevation 980, the level of design high water. The permanent fish and wildlife pool is at elevation 976. Management of the buffer zone around the marsh development by the New Hampshire Fish and Game Department will ensure the future protection of the deeryard. The Department can regulate the water level with stop logs for purposes of fish and wildlife management.

The floodwater retarding structure at site 2 will not change existing land use patterns or vegetative cover except for about 7 acres in the construction area of the dam. This structure will not change the pool level that has been created by the beaver flowage. As in the case of the upstream reservoir site, beaver activity in the area is intermittent and at present the beaver dam is abandoned.

At site 2 potential exists for recreation and fish and wildlife use under present conditions. This includes a minor amount of hunting and nature observation. This potential will not be materially changed by the installation of the structure. In planning the project the principals concluded that the potential for recreation and fish and wildlife use did not justify acquisition of land rights in fee title for public access to the site, nor the expense of monitoring to preclude development of unsanitary conditions and impairment of water quality. For these reasons, public access will not be available to site 2.

The impoundments will affect water temperature just as the existing beaver ponds do. Water temperatures may increase in the summer months. Below both sites the stream flows through dense woods and cools rapidly. Neither impoundment is expected to stratify as both are less than 7 feet deep.

The proposed sites will flood over present marshy areas which contain an accumulation of partially decomposed organic material. Water quality problems may occur from flooding these marshes. The water over these organic soils may be subject to decreases in dissolved oxygen, pH and alkalinity and increases in color, nutrients and dissolved mineral matter. If water quality problems do occur, remedial measures will be taken. The reservoir level will be adjusted to reduce adverse impacts. With time, the organic situation will correct itself.

Eutrophication in the proposed impoundments will occur. There are no man-induced sources of nutrients, but an abundance of nutrients may be expected from the marshy environment. Water level management will help to reduce the concentration of any nutrients in the impoundment.

Changes in evaporation and seepage losses at the sites will be minimal with the installation of the project. Evaporation losses from the existing marshes at sites 1 and 2 will not change. The additional water surface created at site 1 with the enlargement of the existing marsh to the 52-acre impoundment will replace the cover of fir-spruce forest on about 30 acres. Staff members of the Northeast Forest Experiment Station estimate that the rate of evapotranspiration for a fir-spruce forest is about 20 to 22 inches per year. This is consistent with evapotranspiration rates for marshes similar to those at sites 1 and 2. Seepage losses at the dam would also be minimal. Both dams will be placed on and tied into tight, relatively impervious glacial till and rock foundations.

The dam and spillway area at both sites will create about 4 acres of open areas. An additional 13 acres will also be cleared and disrupted during the construction to allow the work to be done. These cleared areas will be seeded with grasses and legumes and will provide food and cover for wildlife from spring through fall.

The channel work will modify about 3,000 feet of Indian Brook in the urban area of Lancaster. The major effect will be the enlargement of the existing channel of which 2,450 feet is natural and 550 feet is already modified. The existing channel averages 5 to 10 feet wide and 2 to 3 feet deep. The project will create a comparatively large trapezoidal channel averaging 23 to 27 feet wide and 6 to 7 feet deep.

Existing fish life and the related food chain will be disturbed in the 3,000-foot reach of channel which will be excavated. Observations, made by biologists of the Vermont Fish and Game Department on channels in Vermont which are similar to Indian Brook, indicate that the food chain will be reestablished about a year after excavation. Sediment produced by construction work on the channel and dams will move downstream through the reach of natural stream which outlets into the Connecticut River.

Installation of the project will create little or no change in the various ecological systems which exist in the watershed. No rare or endangered species will be affected by the project.

Public ownership of the wetland area at site 1 will protect this area from development. This will provide habitat for the fish and wildlife resources for which the region is noted. This is one step in protecting the overall environmental picture, upon which the tourism-based economy depends so heavily.

Recreation trails and walkways will improve access to the forest land. In total, about 250 acres of wetland and upland game habitat will be managed to maintain and improve wildlife in the area.

Timber harvesting techniques and construction of access roads associated with logging operations will further enhance wildlife habitat and create additional recreation opportunities.

Archeological and Historic

The proposed access road will follow the old railroad bed and trail to sites 1 and 2. Construction of the single lane gravel road will disrupt the character of the railroad bed. With the placement of the access road into public ownership and regular maintenance, the location of the bed will be preserved. Public awareness of the Kilkenny Railroad will increase by posting appropriate signs and additional public use.

Approximately 400 feet of the railroad bed and trail will be displaced by construction at site 2 and about 1,600 feet flooded by the pool at site 1. The access road and a connecting trail will reestablish and insure continuity of the present trail.

Along the reach of channel work the new culverts will require the removal of the granite split stone culvert under the spur railroad track.

The project will have no effect on the site of the suspected American Indian settlement at the mouth of the Brook near the Connecticut River.

Provisions of the Preservation of Historical and Archeological Data Act (PL 93 291) will be followed. Should any valuable archeological artifact be uncovered during construction, the Secretary of the Department of the Interior will be notified and an appropriate salvage program initiated. In compliance with the National Historic Preservation Act of 1966 (PL 89 665), the National Register of Historic Places, as published in the Federal Register, was consulted and no listed place will be disturbed or involved in installing the proposed works of improvement.

Economic and Social

The project will contribute to the economy of the area by increasing labor needs during the construction period. Based on experience with similar projects, the project should provide about \$56,000 in wages to the unemployed or underemployed of the area during this period. Thereafter, the project will contribute an additional \$950 annually through operation and maintenance funds. These factors will contribute toward meeting the objective of the Public Works and Economic Development Act of 1965.

The flood protection provided to the urban area will increase the value and development potential of this land. This will encourage development in a planned manner, increase the tax base and encourage more permanent improvements to an area which has existed under the threat of

high water and floods. As this development occurs, technical assistance will be made available to the community to encourage the use of proper construction techniques to reduce erosion and sedimentation problems.

The installation of 66-inch culverts under the three streets will interrupt vehicular traffic for about 1 day at each crossing. Rerouting of traffic will be necessary, adding about one-fourth mile travel distance to users of the roads. The culverts under the railroad tracks will be installed in cooperation with the railroad companies involved.

General

The installation of the structural measures of the project will require the commitment of about 177 acres of land resources in the watershed. The land will be transferred from private to public ownership.

After completion of the project, the channel work through the urban area will occupy 2 acres; the existing channel occupies one-half acre. The work is expected to occupy about 7 acres of land in excavation and spoil spreading. The 9,100 cubic yards of excavated material taken from the channel will be spread on the bank of the brook. The land, presently covered by grasses and shrubs, will be revegetated with similar plants after construction is completed.

Installation of the two reservoirs and the fish and wildlife facilities will require about 170 acres of marsh and forest land. Generally, the area which is now marsh will remain marsh and the majority of forest land will remain intact except that about 30 acres will be converted to marshland and committed to this use for the 100-year design life of the project.

Wildlife habitat improvement and increased public use can be expected from the development and operation of the fish and wildlife marsh.

There will be temporary noise, water and air pollution and accelerated erosion as a result of the construction activity. Construction activities are planned over a 2-year period. Land treatment measures will be completed within a 5-year period.

Upon completion of the project, public use of the watershed will increase. Public access will allow vehicular traffic to the wildlife area, previously open only to loggers, snowmobilers and hikers. An increase in litter may result. However, with the type of facilities provided the major use of the area will be for hunters, fishermen and nature observers.

PROJECT BENEFITS

Total project benefits to be derived from the proposed land treatment and structural measures are estimated to be \$20,330 annually.

Flood damage reduction benefits will amount to \$12,830 annually. Of this amount, \$11,130 will result from direct flood damage reduction and \$1,700 will be derived from such indirect damage reduction as accrues as the result of direct damage reduction. Typical examples of indirect damages are rerouting of traffic, interruption of business, and related delays and cost increases.

Land treatment benefits of \$1,300 annually are expected from flood stage reduction.

The sponsors provided information about expected changes in land values as a result of the project. Analysis of this information revealed an estimated \$2,200 annual benefit for changed land use, the conversion of idle land and hayland to residential development.

The redevelopment benefits attributed to the project installation and the early stages of operation and maintenance are estimated to be \$3,700 annually. These benefits will be derived from work made available to the unemployed and underemployed of the local area.

Secondary benefits from the project will be \$1,600 annually. It is estimated that \$1,200 of these benefits would originate from the project while the other \$400 would be induced by the project. These benefits will be local in nature and were not considered from a national viewpoint. They will be generated by the additional businesses and services instituted as a result of the project.

Benefits resulting from the fish and wildlife development were not evaluated. These benefits would arise from hunting, fishing, habitat preservation, species reproduction, bird watching, outdoor education and limited boating. However, experience has shown that these benefits will equal or exceed the installation and annual \$5,000 cost of the development.

Other benefits to the watershed which were not evaluated relate to the improvement of environmental quality in the area and the improvement of public health and safety in the flood plain.

COMPARISON OF BENEFITS AND COSTS

The project's benefit-cost ratio for structural works of improvement is 1.5:1. The average annual project cost is \$13,000, including \$1,900 for operation and maintenance. Average annual project benefits total \$19,030 including \$1,600 in local secondary benefits. The benefit-cost ratio excluding local secondary benefits is 1.3:1.

Although fish and wildlife benefits were not evaluated, they are expected at least to equal the cost of the project's fish and wildlife measures.

PROJECT INSTALLATION

Installation of land treatment and structural measures included in this plan is scheduled over a five-year period and land treatment measures will be installed more or less uniformly over this entire period. During the first and second years the sponsors will obtain all land rights, and the Soil Conservation Service will complete geologic investigations and all engineering surveys and designs. During the third year multiple-purpose structure 1 and floodwater retarding structure 2 will be constructed. The channel work will be accomplished and the fish and wildlife facilities installed during the fourth year.

The Coos County Conservation District will be responsible for local coordination of activities between the sponsors and the cooperating agencies. The District will provide leadership in the present and accelerated land treatment programs and inform local residents and sponsors of progress on the project throughout the installation period.

Landowners and operators will accomplish the land treatment measures utilizing technical assistance available through the Coos County Conservation District. This technical assistance will be provided by the Soil Conservation Service, and by the New Hampshire Cooperative Extension Service and Division of Resources Development cooperating with the U. S. Forest Service.

The New Hampshire Water Resources Board will secure all land rights for installation, operation and maintenance of structural works of improvement, and will provide such legal service, surveys and other assistance as may be needed to acquire the land rights. If necessary, the Board will exercise its power of eminent domain to acquire land rights for the flood prevention measures. The Town of Lancaster will assist the Board in securing land rights for the channel work. The Fish and Game Department will assist the Board in securing land rights for the multiple-purpose structure 1 and for the fish and wildlife facilities, including the public access road to the development. The Water Resources Board, the Fish and Game Department and the Town of Lancaster will acquire the necessary land rights with available funds or through appropriations as required.

The Fish and Game Department will be responsible for meeting the requirements of local and state health laws applicable to the installation, operation and maintenance of the fish and wildlife facilities at site 1.

The Soil Conservation Service will provide the engineering services required for surveys, designs and preparation of plans and specifications for structures 1 and 2 and the channel work. The New Hampshire Fish and Game Department will provide the engineering services for the fish and wildlife facilities to be installed at site 1.

The Water Resources Board will administer construction contracts for structures 1 and 2 and for the channel work. The New Hampshire Fish and Game Department will administer construction contracts for the fish and wildlife facilities. The Department, in cooperation with the Town, will

use its own work force and equipment to upgrade the access road for public use. In this way the Department will defray part of the construction costs. The Water Resources Board and the Fish and Game Department each will provide such administrative and clerical personnel, facilities, supplies and equipment as are necessary to advertise, award and administer these contracts. In addition, they will provide such inspection services as they deem necessary in installing works of improvement. The Soil Conservation Service will review the plans for the fish and wildlife facilities prepared by the Department of Fish and Game and will provide a government representative and necessary inspection services during construction to ensure installation of all structural measures in accordance with plans and specifications.

All land acquisition will be in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL 91-646 (84 Stat. 1894). Procedures for appraisal and acquisition will be followed as outlined in USDA regulations. Installation of this project will not cause the displacement of persons, businesses and farms as defined in the Act.

Land rights are necessary for the installation of the channel work for the installation of new, larger culverts under three roads and two railroads. These are the responsibility of the Town of Lancaster. In order to defray part of its costs for land rights, the Town plans to install the culverts under the three roads using its own work force and equipment. The performance of this work by the Town will meet part of the Town's responsibility for providing land rights. The work done will conform to drawings and specifications approved by the Soil Conservation Service and will be accomplished according to a mutually agreeable schedule. The sponsors will assume the same responsibility for the work as a contractor would if the work were performed under contract.

FINANCING PROJECT INSTALLATION

The sponsoring local organizations are legal entities of state government and are empowered and qualified to install, operate and maintain the project measures included herein. They have reviewed the estimated program costs outlined in tables 1 and 2 and have participated in cost sharing decisions. They have given the Soil Conservation Service adequate assurance that the share of installation costs allocated to each of them will be available when required and in the amounts due.

Cost sharing and other assistance, currently available through existing conservation programs at the Coos County Conservation District, and state and federal agencies cooperating in the project, are an integral part of this plan. It is expected that such assistance will remain available, at least in the amounts and at the rates that existed at the time of the development of this work plan.

Individual landowners and operators will bear the costs of applying land treatment measures on private land, utilizing such cost sharing assistance as may be available through local, state and federal programs. Similarly, the Town of Lancaster will bear the cost of installing measures on Town lands.

Technical assistance will be provided through the present programs of the Coos County Conservation District assisted by the Soil Conservation Service and the New Hampshire Cooperative Extension Service and Division of Resources Development in cooperation with the USDA Forest Service. PL 566 funds will be provided for any additional technical assistance needed in accelerating the installation rate of land treatment measures.

The sponsors' share of the costs for structural measures will be appropriated from funds available under their existing program authorities.

Currently the New Hampshire Water Resources Board is financing land rights and other costs, including the administration of contracts, involved in PL 566 watersheds in New Hampshire through capital budget requests. The Board will finance all costs for administration of contracts and other project administration services necessary for the installation of structures 1 and 2 and the channel work. In addition, the Board will finance all land rights costs for structure 2 and share the costs with PL 566 for structure 1.

The Fish and Game Department will bear the sponsors' share of the construction cost for structure 1, with PL 566 providing the federal share. The Department will share the construction costs for the fish and wildlife facilities at site 1 with PL 566 funds and will pay for engineering services, land rights and the necessary project administration costs. Use of the Department's own work force and equipment will defray that part of its cost related to the fish and wildlife facilities.

The Fish and Game Department intends to utilize Pittman-Robertson funds, within established limits, to defray the local share of the construction costs for the multiple-purpose structure and facilities. Land in excess of that required for the multiple-purpose structure will be purchased through a cost sharing arrangement of state funds and Pittman-Robertson funds.

The Town of Lancaster will finance the land rights costs of channel work in the urban area. These costs include the expenditures of installing new 66-inch diameter larger culverts under three roads and two railroads and securing permanent easements to construct, operate and maintain the channel and appurtenances. To defray part of its costs for land rights, the Town plans to use its own work force and equipment to install the culverts.

Public Law 566 funds will pay for structural measures during the installation period as set forth in the watershed work plan agreement pursuant to the following conditions:

1. The sponsors have provided assurance to the Soil Conservation Service, in writing, that they have legal authority, sufficient funds, and are willing and able to obtain all land rights for structural works of improvement.
2. The contracting agency is prepared to discharge its responsibilities.
3. Project agreements and operation and maintenance agreements have been executed.
4. Public Law 566 funds have been made available through Congressional appropriations for this purpose.

Prior to entering into agreements that obligate funds of the Service, the Water Resources Board and the Fish and Game Department will have a financial management system for control, accountability, and disclosure of PL 566 funds received, and for control and accountability for property and other assets purchased with PL 566 funds.

Program income earned during the grant period will be reported on the sponsor's request for advance or reimbursement from the Service.

PROVISIONS FOR OPERATION AND MAINTENANCE

The land treatment measures installed in the watershed will be operated and maintained by the landowners or operators. Technical assistance, made available through the Coos County Conservation District, will be provided by the Soil Conservation Service, the New Hampshire Cooperative Extension Service, and the Division of Resources Development in cooperation with the U. S. Forest Service.

Operation and maintenance of all structural measures will be the responsibility of the sponsors. The Town of Lancaster will operate and maintain the channel work. Funding will be provided through the Town's annual operation and maintenance budget.

The New Hampshire Water Resources Board will operate and maintain the dam, principal spillway and emergency spillway at each of the two reservoir structures except for the operation of the stop logs at structure 1 which are associated with the fish and wildlife water reservoir. The Board has been authorized and funded in the past to operate and maintain flood prevention structures in PL 566 projects for which the Board is a sponsor.

The New Hampshire Fish and Game Department, through its regular budget, will operate and maintain the fish and wildlife water resource and facilities associated with structure 1. The Department will operate the stop logs at structure 1 to control the water level for proper management of the fish and wildlife habitat in the marsh. Fish stocking and management of fish and wildlife at site 1 will also be the responsibility of the Department. The Department will be assisted by the Town of Lancaster in the maintenance of the access road, parking lot and boat ramp.

The operation and maintenance of the fish and wildlife development at site 1 will conform to the requirements of the Division of Public Health Services and the Water Supply and Pollution Control Commission which act as regulatory agencies in such matters. It is expected that sanitary facilities will not be needed since the New Hampshire Fish and Game Department projects a low density of use. The Department will monitor use at the site, however, and if its surveys indicate sufficient use to require sanitary facilities, the Department will provide facilities which comply with all local and state laws (dealing with public health, water quality and environmental quality).

The annual operation and maintenance cost for all structural measures is estimated to be \$1,900. Routine maintenance of the channel will include removal of debris from culverts, upkeep of channel bank vegetation, and repair as needed of the concrete work in the grade stabilization structure. This will require \$1,300 annually. Maintenance of the dams will require \$600 annually and will include the removal of floating debris from the reservoirs, preservation of earth embankment and emergency spillway vegetation, and repair as needed of the concrete work in the principal spillways.

The cost to operate and maintain the fish and wildlife facilities is estimated to be \$1,300 annually. This will include keeping the access

road, parking area and boat ramp in good condition for public use and the area clean and free of debris.

Representatives of the Town of Lancaster, the Coos County Conservation District, the New Hampshire Fish and Game Department, and the New Hampshire Water Resources Board will inspect the structures annually with additional inspections following any major storm or unusual occurrence that could affect the proper operation of the facilities. During the first 3 years following completion of the project, the Soil Conservation Service will assist in these inspections. After the third year, the sponsors will continue the annual inspections. They will prepare inspection reports and submit a copy of each report to the Service. The Service may make inspections at any time to assure proper operation and maintenance.

Dams will be inspected to determine the condition of the embankment, vegetation, principal and emergency spillways and other appurtenances of the structures. The channel and grade stabilization structure will be inspected to determine the condition of the concrete works, the channel bank vegetation, the channel stability and the culverts. Inspection items at the fish and wildlife facilities will include the condition of the access road, boat ramp and parking lot, and the sanitary conditions at the site.

Each operation and maintenance agreement sets an establishment period for structural works of improvement and for associated vegetative work. During the establishment period, the Soil Conservation Service, using PL 566 funds, may cost share on repairs or additional work which result from unknown latent conditions or deficiencies in Service work. Repairs may be cost shared in the same ratio as authorized for the original construction of the specific work involved.

Repairs or additional work which are not eligible for PL 566 financial assistance include work on the basic facilities for fish and wildlife development and work resulting from improper operation and maintenance.

The appropriate sponsor and the Service will execute an operation and maintenance agreement prior to the signing of any project agreement for each work of improvement. The operation and maintenance agreement will include specific provisions for retention and disposal of property acquired or improved with PL 566 financial assistance. An operation and maintenance plan will be prepared for each structural measure in accordance with guidelines outlined in the New Hampshire Watersheds Operation and Maintenance Handbook for PL 566 projects.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Indian Brook Watershed, New Hampshire

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) <u>1/</u>					Total		
			PL 566		Other					
			SCS <u>3/</u>	FS <u>3/</u>	Total	SCS <u>3/</u>	FS <u>3/</u>		Total	
Land Treatment	Acres	15								
Land Areas <u>2/</u>		1,125								
Cropland		-								
Forest land										
Urban		105								
Other										
Technical Assistance			4,100	8,100	12,200	400	1,500		1,900	2,000
TOTAL LAND TREATMENT			4,100	8,100	12,200	32,700	35,800		68,500	58,000
Structural Measures										
Construction										
Multiple-purpose structure <u>1</u>	No.	1	42,700		42,700	10,400			10,400	53,100
Floodwater retarding structure <u>2</u>	No.	1	50,700		50,700					50,700
Fish and Wildlife facilities	No.	1	10,000		10,000	10,000			10,000	20,000
Channel work <u>4/</u>										
(N)	Mi.	0.45	29,700		29,700					29,700
(M)	Mi.	0.10	4,200		4,200					4,200
Subtotal Construction			137,300		137,300	20,400			20,400	157,700
Engineering Services			12,300		12,300	2,000			2,000	14,300
Relocation Payments										
Project Administration										
Construction Administration			9,600		9,600	500			500	10,100
Other			5,200		5,200	2,100			2,100	7,300
Subtotal Administration			14,800		14,800	2,600			2,600	17,400
Other Costs										
Land Rights			4,500		4,500	57,200			57,200	61,700
TOTAL STRUCTURAL MEASURES			168,900		168,900	82,200			82,200	251,100
TOTAL PROJECT			173,000	8,100	181,100	114,900	35,800		150,700	331,800

1/ Price Base 1975.

2/ Includes only areas estimated to be adequately treated during the project installation period of 5 years. Treatment will be accelerated throughout the watershed; and dollar amounts apply to total land area, not just adequately treated areas.

3/ Federal agency responsible for assisting in installation of works of improvement.

4/ Type of channel before project: (N) - an unmodified, well-defined natural channel or stream, (M) - previously modified channel.

5/ Includes cooperative fire control and pest management programs, \$1,000 for all forest land.

Date: September 1975

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

INDIAN BROOK WATERSHED, NEW HAMPSHIRE

Measures	Unit	Applied to Date	Total Cost (Dollars) ^{1/}
<u>Land Treatment</u>			
Access Roads	mi.	2	11,000
Brush Control	ac.	25	250
Pasture & Hay Land Management	ac.	30	1,350
Wildlife Upland Habitat Management	ac.	300	1,500
Wildlife Wetland Habitat Management	ac.	50	250
Woodland Improved Harvesting	ac.	25	250
Pasture & Hay Land Planting	ac.	10	700
Mulching	ac.	2	300
Critical Area Planting	ac.	2	800
Conservation Cropping System	ac.	5	500
Recreation Area Improvement	ac.	5	600
Tree Planting	ac.	15	650
Management Plans	No./ac.	3/330	150
Hydrologic Cultural Operations	ac.	23	900
Fire Control	ac.	1,290	1,300
TOTAL	xxx	xxx	20,500

^{1/} Price Base 1970.

Date: September 1975

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Indian Brook Watershed, New Hampshire
(Dollars) 1/

Item	Installation Cost - PL 566 Funds			Installation Cost - Other Funds			Total Instal- lation Cost		
	Construc- tion	Engi- neering	Land Rights	Total PL 566	Construc- tion	Engi- neering		Land Rights	Total Other
Multiple-purpose Structure 1	42,700	4,400	4,500	51,600	10,400	--	4,500	14,900	66,500
Floodwater Retarding Structure 2	50,700	3,700	--	54,400	--	--	3,100	3,100	57,500
Fish and Wildlife Facilities	10,000	--	--	10,000	10,000	2,000	9,500	21,500	31,500
Subtotal	103,400	8,100	4,500	116,000	20,400	2,000	17,100	39,500	155,500
Channel Modification ^{2/}									
132+50 - 145+70 (N)	25,100	3,100	--	28,200	--	--	8,100	8,100	36,300
145+70 - 151+25 (M)	4,200	500	--	4,700	--	--	16,000	16,000	20,700
151+25 - 161+70 (N)	4,600	600	--	5,200	--	--	16,000	16,000	21,200
Subtotal	33,900	4,200	--	38,100	--	--	40,100 ^{3/}	40,100	78,200
Project Administration	xxx	xxx	xxx	14,800	xxx	xxx	xxx	2,600	17,400
GRAND TOTAL	137,300	12,300	4,500	168,900	20,400	2,000	57,200 ^{4/}	82,200	251,100

1/ Price Base 1975.

2/ Type of channel before project: (N) - an unmodified, well defined natural channel or stream,
M(12/73) - previously modified channel.

3/ Includes \$38,400 for replacement of road and railroad culverts.

4/ Includes \$1,800 for surveys, legal fees and other costs.

Date: September 1975

TABLE 2B - FISH AND WILDLIFE FACILITIES

ESTIMATED CONSTRUCTION COSTS

Indian Brook Watershed, New Hampshire
(Dollars) 1/

Item	Number ^{2/}	Estimated Unit Cost	Total Construction Cost
Access Road (Gravel)	1 mile	19,500	19,500
Boat Ramp (Crushed Stones)	1	200	200
Parking Lot	5 cars	40	200
Sign	1	100	100
GRAND TOTAL			20,000

1/ Price Base 1975

2/ Estimated quantity, subject to minor variation at time of
detailed planning.

Date: September 1975

TABLE 3 - STRUCTURAL DATA
STRUCTURES WITH PLANNED STORAGE CAPACITY
Indian Brook Watershed, New Hampshire

ITEM	UNIT	Structure Number		TOTAL
		1	2	
Class of Structure	--	C	C	
Drainage Area (Total)	Sq.Mi.	1.11	1 45	
Controlled	Sq.Mi.	--	1.11	
Curve No. (1 day)(AMC II)		68	68	
Tc	Hrs.	2.7	1.5	
Elevation Top of Dam	Ft.	983.5	965.5	
Elevation Crest Emergency Spillway	Ft.	979.2	961.0	
Elevation Crest High Stage Weir	Ft.	977.0	--	
Elevation Crest Low Stage Weir	Ft.	976.0 ^{3/}	958.0	
Maximum Height of Dam	Ft.	14.5	14.5	
Volume of Fill	Cu.Yds.	7000	2300	9300
Total Capacity ^{4/}	Ac.Ft.	296	54	350
Sediment Submerged 100 years	Ac.Ft.	4.0	1.5 ^{1/}	5.5
Beneficial Use (Fish and Wildlife)	Ac.Ft.	116	--	116
Retarding	Ac.Ft.	176	47	223
Between high and low stage	Ac.Ft.	53	--	53
Surface Area				
Sediment pool	Acres	(2)	7	7
Beneficial use pool (Fish and Wildlife)	Acres	52	--	52
Retarding pool ^{4/}	Acres	59	22	81
Principal Spillway				
Rainfall Volume (areal)(1 day)	In.	6	6	
Rainfall Volume (areal)(10 day)	In.	11	11	
Runoff Volume (10 day)	In.	9.5	9.5	
Capacity of Low Stage (max.)	cfs	11	--	
Capacity of High Stage (max.)	cfs	112	103	
Frequency Operation - Emergency Spillway	% chance	^{2/}	^{2/}	
Length of Weir	Ft.	10	6.5	
Emergency Spillway				
Rainfall Volume (ESH)(areal)	In.	8.10	8.10	
Runoff Volume (ESH)	In.	4.32	4.32	
Storm Duration	Hrs.	6	6	
Type		Veg.	Veg.	
Bottom Width	Ft.	133	127	
Velocity of Flow (Ve)	Ft./Sec.	3.6	4.3	
Slope of Exit Channel	Ft./Ft.	.05	.033	
Maximum Reservoir Water Surface Elev.	Ft.	980	962.1	
Freeboard				
Rainfall Volume (FH)(areal)(6 hour)	In.	19.80	19.80	
Runoff Volume (FH)	In.	15.09	15.09	
Storm Duration	Hrs.	6	6	
Maximum Reservoir Water Surface Elev.	Ft.	982.2	964.4	
Capacity Equivalents				
Sediment Volume	In.	.07	.08	
Retarding Volume	In.	2.97	2.61	
Beneficial Volume	In.	1.96	--	

^{1/} Sediment in 7 ac.ft. beaver pond.

^{2/} Emergency spillway frequency of operation less than 1%.

^{3/} 3-foot weir with flashboard control down to elevation 970.

^{4/} Crest of emergency spillway.

Date: September 1975

TABLE 3A - STRUCTURE DATA
CHANNELS

Indian Brook Watershed, New Hampshire

Channel Name	Station	Drainage Area sq.mi.	Capacity cfs		Water Surface Elev.	Hydraulic Gradient ft./ft.	Channel Dimensions ^{1/}		Velocity fps		Excavation cu.yds.	Type of Work	Before Project	
			Req'd ^{2/}	Design			Bottom Grade %	Depth of Flow(ft.)	Aged	As-Built			Type of Flow ^{8/}	Flow Conditions ^{8/}
Indian Brook	132+50 ^{2/}	0.63	165	226	856.01	.00017	.00045	6.9	4/	5/	200	II	N	Pr.
	133+00		165	165	855.81	1.08'head loss	.01	7.2	1.47	1.85				
	144+20	0.63	165	165	854.73	1.08'head loss	.01	7.1	1.36	1.85	5,000		N	
	145+70 ^{6/}	0.63	165	165	854.73	1.08'head loss	.01	7.1	1.40	1.85	5,150		M	
	148+75 ^{7/}	0.65	170	229	853.65	.00025	.00045	6.5	1.66	1.85	5,890		M	
	151+25 ^{6/}	0.65	176	176	853.56	1.66'head loss	.01	6.6	1.68	1.85	7,060		N	
	156+25	0.67	182	184	851.73	.00042	.00045	5.9	2.08	1.85	8,830		N	
	161+70			Lower Limit of Channel Culvert Replacement							9,100		N	

1/ Channel work - 6-foot bottom width and 1½:1 side slopes.

2/ Type "C" drop spillway and upper limit of channel work.

3/ Based on 1% chance peak discharge.

4/ "n" value of .032 (1% chance peak discharge).

5/ "n" value of .027 (10% chance peak discharge).

6/ 66-inch corrugated metal pipe.

7/ This station is typical of the reach of channel work. The tractive force theory was used to check channel stability. The results were $T_b = 0.003$ psf, $T_s = 0.024$ psf, with an allowable tractive force of 0.033 psf.

8/ Type of work: II-Enlargement or realignment of existing channel or stream; N - An unmodified, well-defined natural channel or stream; M (12/73) - previously modified channel; Pr - Perennial flows at all times except during extreme drought.

Date: September 1975

TABLE 3B - STRUCTURAL DATA

GRADE STABILIZATION STRUCTURE

Indian Brook Watershed, New Hampshire

Site	Drainage Area (sq.mi)	Drop (ft.)	Concrete (cu.yd.)	Type of Structure
Station 132+50	0.63	5.7	44	Type C Drop Spillway

Date: September 1975

TABLE 4 - ANNUAL COST

Indian Brook Watershed, New Hampshire
(Dollars) 1/

Evaluation Unit	Amortization <u>2/</u> of Installation Cost	Operation and Maintenance Cost	Total
1. Multiple-purpose site with Fish and Wildlife Develop- ment; 1 flood prevention site; and channel work with 1 drop structure	10,100 (3,700) <u>3/</u>	1,900 (1,300) <u>3/</u>	12,000
Project Administration	1,000	xxx	1,000
GRAND TOTAL	11,100	1,900	13,000

1/ Price Base 1975.

2/ 100 years at 5-7/8 percent interest.

3/ Fish and wildlife costs not included in benefit-cost ratio.
Costs and benefits are assumed to be equal.

Date: September 1975

TABLE 5 - ESTIMATED AVERAGE ANNUAL
FLOOD DAMAGE REDUCTION BENEFITS

Indian Brook Watershed, New Hampshire
(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project <u>2/</u>	
Floodwater			
Crop and Pasture	30	0	30
Nonagricultural			
Urban	10,700	0	10,700
Road & Bridge	400		400
Subtotal	11,130	0	11,130
Indirect	1,700		1,700
TOTAL	12,830		12,830

1/ Price base 1975 except adjusted normalized prices for crop and pasture.

2/ Damages and benefits will accrue from floods of greater magnitude than the 100-year frequency.

Date: September 1975

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Indian Brook Watershed, New Hampshire
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS <u>1/</u>				<u>3/</u> Average Annual Cost	<u>4/</u> Benefit Cost Ratio
	Damage Reduction	Changed Land Use	Redevelopment	Secondary	Total	
1. Multiple-purpose site; 1 flood retarding and channel work	11,530	2,200	3,700	1,600	19,030	1.6:1
Project Administration	xxx	xxx	xxx	xxx	xxx	
GRAND TOTAL	11,530 <u>2/</u>	2,200	3,700	1,600	19,030	1.5:1

1/ Price Base 1975 except adjusted normalized prices for crop and pasture.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$1,300 annually.

3/ From table 4.

4/ Fish and wildlife benefits and costs are assumed to be equal and are not included in this comparison.

Date: September 1975

INVESTIGATIONS AND ANALYSES

Land Treatment

The Coos County Conservation District, the Soil Conservation Service, the Cooperative Extension Service, the Division of Resources Development, the Forest Service and the Agricultural Stabilization and Conservation Service made a cooperative study to determine the requirements for an accelerated land treatment program within the watershed. Considering both present and expected land use and evaluating the currently applied land treatment measures, the study estimated the total land treatment needs over the next five years. The effects and scope of the existing program were compared with the total anticipated needs to determine an optimum level for the accelerated program.

Forestry

Information on the hydrologic condition of the forest land in the watershed and the reasons for the present hydrologic condition were obtained from a series of systematically selected observation plots. This information served as the basis for estimated precipitation-runoff curve numbers and an assessment of land treatment needs for forest land. Data obtained included measurements of the litter and humus layers, determination of soil type, and other hydrologic factors, and a record of the frequency of disturbance factors such as fire, grazing, cutting, logging and abnormal infestation of insects.

Forest fire protection is provided by the New Hampshire Division of Resources Development through the Clarke-McNary Cooperative Fire Control Program.

There were no fires on the watershed during the past five-year period. Established watershed and statewide goals have been met and the present degree of protection is adequate to meet any increased hazard and risk which might result from the project's installation.

Economics

Floodwater damages were computed using the stage-frequency method of analysis for urban, agricultural, and road and bridge damages. Possible damages and benefits with and without the project were compared for floods up to and including 500-year magnitude. Graphical analysis was used to determine damage reduction benefits.

Cross section and evaluation reaches in the damage area were selected jointly by the hydrologist and the economist. Seven cross section and three evaluation reaches were used to relate depth of flooding to damage. The relationship between stages in Indian Brook and the level of basement flooding was based on the geologist's investigation of subsurface material. Interviews with local residents verified the calculated stage reduction relationships and Technical Note WS-UD-19, Basic Data for Evaluating Floodwater Damages to Urban Properties, was used in stage-damage estimates.

Damages to pasture and hay land were determined from depth of flooding. The cost of debris removal was added to pasture and hay land damages. Damage relationships are given in Technical Note WS-UD-16, Basic Data for Evaluating Floodwater Damages to Crops and Pastures in the Northeast. Average annual damage was determined with a weighted average formula which related the dollar value of a crop at a given time with the frequency of flooding for that time. Road and bridge damage estimates were based on an interview with the town manager who has experience and knowledge of past costs and frequency of repairs.

The fish and wildlife development benefits have been considered to equal the costs for the purpose of economic justification. This consideration is based on a determination made by the Secretary of Agriculture as a result of the long history of federal and state participation in measures to enhance fish and wildlife resources.

Redevelopment benefits were based on the expected employment of unemployed and underemployed local laborers during project construction and during the early stages of operation and maintenance. The labor figures from a completed New Hampshire watershed project, Oliverian Brook, were used. Wages paid to local laborers in the Oliverian project accounted for 28.8 percent of the construction cost. The same percentage was applied to this project and amortized. Operation and maintenance redevelopment benefits were based on the assumption that one-half of the annual operation and maintenance cost will go to the local labor force in a 20-year decreasing annuity, moving from full value to zero at the end of the 20 years.

Changed land use (enhancement) benefits were based jointly on expected changes resulting from flood plain protection and on local real estate values. Land use changes, generally from hayland or idle land to residential area, and the resultant increased land values are expected to occur within ten years after project installation. Associated costs involved for utilities related to changed land use were also considered.

Floodwater damages to urban properties were adjusted in accordance with Technical Note WS-UD-26, which offers guidelines and adjustment factors for estimating changes in future value. The guidelines are based on the premise that property and labor values will increase at essentially the same rate as per capita income. Indirect damages, attributed to interruption of services, delay of normal activities and rerouting of traffic, were estimated to be 10 percent of agricultural, 15 percent of urban, and 20 percent of road and bridge direct damages.

The secondary benefits stemming from the project were estimated to be 10 percent of the total direct project benefits. All of these benefits were considered only on a local basis, not from a national standpoint.

All structural works of improvement were amortized at 5-7/8 percent interest for an evaluation period of 100 years.

The Use of Facilities method was used to allocate project costs to project purposes. Costs and benefits were based on 1975 prices except for crop and pasture benefits, for which adjusted normalized prices were used.

The evaluation procedures used are outlined in the Soil Conservation Service Economic Guide for Watershed Protection and Flood Prevention.

Engineering

Selection of structural works of improvement for flood prevention was based on the findings of the economic, hydrologic, geologic, and biologic studies of existing conditions and the effects of alternative combinations of structures and land treatment measures.

A base map was made to show pertinent physical features of the watershed such as the drainage pattern, road system, village and boundary lines. U. S. Geological Survey topographic maps and aerial photographs were used to locate drainage boundaries and potential structure sites.

A field examination was made of possible flood water detention sites. The sites exhibiting the best storage potential and the most promise for reducing downstream damages were selected for more detailed study.

A topographic map, developed by plane table survey, was used to determine the storage capacity and the fill and excavation volumes for each site. A transit cross section and profile survey, made in the area of the proposed channel work, was used to determine channel excavation quantities. All excavation and fill quantities were determined by the average end area method.

Fill volumes, emergency spillway excavation, principal spillway costs, and easements costs were all correlated to determine the most economical structural proportions.

Emergency spillway locations and layouts at the sites were planned using geologic information from test pit investigations. These studies also indicate that sufficient impervious borrow material is available in the emergency spillway area at site 2 to meet the construction needs of both sites.

Type C, straight drop spillways were planned for both sites. At site 1 (the upper site), this type of spillway will allow greater discharges with small increases in reservoir elevation. This will minimize the detention volume necessary to store excess floodwater, or water which has not been drawn down within ten days. Also, the emergency spillway can be set at an elevation which allows the use of a natural topographic saddle as the spillway approach, minimizing both excavation and expenditure.

The principal spillway discharge capacity increased to 112 cfs due to raising the emergency spillway crest 0.4 foot above the elevation set by the 100-year principal spillway design storm. This crest was raised so that 80 percent of the net floodwater detention storage for the 100-year storm is available 10 days after the time of maximum storage.

Elevating the emergency spillway crest was done as a safety measure which reduces the probability of spillway operation to beyond the 100-year event. The 100-year storm should cause a discharge of 88 cfs at site 1 and 103 cfs at site 2 downstream.

Stop logs, which can be removed to lower the pool elevation, will maintain the normal pool at a level one foot below the high stage crest of the drop spillway.

The drop spillway of the lower structure at site 2 supplements the two emergency spillways in their function of keeping the freeboard storm from flowing out of the watershed via a natural topographic saddle in the drainage divide.

Structure classification for the dams was based on their proximity to residential areas and other damage centers. The sites have been planned as class "c" structures in accordance with SCS Engineering Memorandum 27.

Design of the Indian Brook channel was governed by channel stability considerations. Design velocities were based upon guidelines set up in SCS Technical Release 25, "Planning and Design of Open Channels". The tractive force theory was used.

The channel was designed for a 100-year flow. The "as-built" velocity will be 1.85 feet per second for the 10-year flow. Experience with other channels indicates that with the maintenance program agreed upon, the channel will be stable at this velocity.

The channel design capacity was based upon an "aged" n of .032. Test pits were made throughout the reach of channel to be modified. Mechanical analysis conducted on samples taken from the test pits determined particle size and distribution. This information was used to determine construction condition and to establish allowable velocities and tractive forces. Riprap will be placed around culverts where allowable velocities may be exceeded.

Construction and maintenance of a deepened channel within the unconfined aquifer will be difficult. Construction plans will call for techniques such as pilot channel excavation followed by such excavation as is necessary to approximate the final channel shape.

A type C, straight drop spillway is planned at the upstream end of the channel work reach. This will maintain the channel in its present condition above the structure and allow a flat design gradient below so that design flows will not reach erosive velocities.

The State of New Hampshire Water Resources Board and the Fish and Game Department have reviewed all plans for structural works of improvement. The SCS State Conservation Engineer has reviewed the recommended measures as well as the alternatives which were eliminated during the course of planning.

Preliminary designs are in accord with the Soil Conservation Service design criteria set forth in Engineering Memorandum SCS-27, Technical Release No. 25, U. S. Weather Bureau Technical Papers No. 40 and 49, and other recognized sources of reference material.

Final designs for structural works of improvement will be submitted to the New Hampshire Water Resources Board for approval.

Hydrology

Hydrologic and hydraulic analyses were developed from the procedures in the National Engineering Handbook of the Soil Conservation Service, Section 4, Hydrology (NEH-4), and Section 5, Hydraulics (NEH-5).

The U. S. Geological Survey does not maintain a stream gaging station within the watershed.

The National Oceanic and Atmospheric Administration, U.S. Department of Commerce, maintains a gaging station in Lancaster from which climatological data was obtained.

A study of the hydraulic and hydrologic characteristics of the watershed was made by examining material drawn from the geology, topography, soils, land use, channel capacity, and climatological influences of the area. As a result of this study, the watershed was divided into three subareas and four routing reaches.

Hydrologic classification of the soils in the watershed was made by the Soil Conservation Service. The U. S. Forest Service assigned present and future precipitation-runoff curve numbers to the forest lands using SCS soil classifications to supplement their studies of cover condition. Information on the hydrologic condition of the forest land in the watershed was collected systematically; and measurements of litter, humus, soil type, and other hydrologic factors were recorded and analyzed.

Runoff-curve numbers for present and project conditions in open and miscellaneous areas were developed from data prepared by the local field office and the watershed planning staff of the Soil Conservation Service. Composite runoff-curve numbers were developed for each subarea. The evaluation of the effect of land treatment measures was based on procedures outlined in SCS Technical Note WS-HYDROL-EWP-2 (UD). Times of concentration for the subareas were computed either by the stream hydraulics procedure in NEH-4, or by the SCS nomograph for watershed lag based on runoff curve number, land slope, and channel length. Time of travel for channelized flow was computed using Manning's formula for open channel flow.

Valley and channel or bridge cross sections were surveyed at 25 selected locations in the watershed. One valley and channel cross section on the Connecticut River was surveyed downstream from the watershed.

Water surface profiles for present and with-project conditions in the urban reaches of Lancaster were computed by the water surface profile program of the ADP Unit at the TSC, Upper Darby, Pennsylvania. Other applicable water surface profiles were based on the assumption of normal flow. Weir, culvert, and bridge equations were used at various control sections. Rating curves for key cross sections were plotted from computed water surface profiles.

Present and project condition discharge-frequency curves for key stream reaches were developed from storm routings. Twenty-four-hour duration storms for the 2-, 5-, 10-, and 100-year recurrence intervals were developed and routed using either the convex method or the storage indication method from SCS National Engineering Handbook, Section 4, where each was applicable. Precipitation data was taken from U. S. Weather Bureau Technical Paper No. 40.

The required floodwater retarding volume for sites 1 and 2 was determined using procedures outlined in NEH-4, Chapter 21. Type C, straight-drop principal spillways were used at the sites. Spillways of this type are desirable in sites where conditions restrict floodwater storage capacity. Further, Type C spillways present the least costly alternative and maintain flood flow water level fluctuations within a range which does not affect fish and wildlife habitat adversely.

Emergency spillway and freeboard hydrographs were developed according to the criteria in Chapter 21, NEH-4. Precipitation values were taken from the minimum six-hour precipitation maps in Engineering Memorandum SCS-27. The hydrographs were routed through the emergency spillway using the UD flood routing method.

Biology

Initial inventories and appraisals of fish and wildlife potential in the Indian Brook watershed project were made by the Soil Conservation Service's field biologist during preliminary planning stages with other watershed planning personnel. Subsequent field surveys were made by biologists from the New Hampshire Fish and Game Department, the U. S. Fish and Wildlife Service, and the Soil Conservation Service. General findings indicated the presence of a variety of wildlife in the watershed. Deer, hare, grouse and waterfowl are of primary importance. Studies indicated that the stream fishery was of minor value, especially in the lower reaches of the stream.

Fish and wildlife potential was analyzed for a variety of alternative development measures. Results indicated that site 1 would be best for a shallow wildlife marsh development.

Agencies and sponsors participated in further meetings and studies to finalize the fish and wildlife development plans.

Geology

Sediment storage requirements were determined for structures 1 and 2. The two structures are in series within a 926-acre watershed. This

drainage area is a very low sediment producer, since about 75 acres of the area consist of upland swamps -- open water and beaver flowage -- and the remaining area is in woodland cover. The volume allocated for sediment storage is based on the predicted sediment delivered to the reservoirs during the 100-year design period. Due to the configuration of the reservoirs, the sediment is allocated to permanent storage. At the lower site, this volume will accumulate in the space occupied by the existing beaver pond.

Prior to making a field reconnaissance all published geologic information, U. S. Geologic Survey geologic maps, quadrangles and reports were researched. Then preliminary geologic investigations were conducted along the reach of channel work and at the structure sites, including reservoir areas.

Organic accumulation in the reservoir areas was probed and sampled. A field reconnaissance conducted at the upper structure site evaluated the surficial geology. At the site of the lower structure a seismic study and test pitting program were conducted. Geologic conditions and interpretations of the subject areas have been presented in preliminary engineering geology reports, plans and profiles.

The following are brief summaries of geologic conditions at the sites of the proposed works of improvement:

Site 1 -- An embankment will be constructed over the bedrock control on a large upland swamp. The surficial material consists of a thin cover of bouldery glacial till. The bedrock surface is very irregular and shallow throughout the area and appears in outcroppings along the channel. A "topographic saddle" will function as an erosion resistant emergency spillway.

Site 2 -- Surficial material in the construction area is glacial till. Bedrock outcrops are evident immediately downstream from the proposed embankment. At the structure site the overburden is sufficiently thick to avoid rock excavation in the emergency spillway and provide a positive cutoff in earth.

Construction of an emergency spillway at site 2 will yield borrow material of sufficient quantity and quality for construction of the embankments at both sites.

The dam sites as well as the entire perimeters of the reservoirs are in an environment of glacial till. This overburden is generally quite dense and relatively impervious. The bedrock is granitic. It is strongly foliated and medium-grained. It is fractured and jointed, but no significant seepage is anticipated within the fracture and joint system. Borrow material (till) is readily available and well-suited for the construction of homogeneous embankments. This material is silty, fine to medium sands with a trace of coarse sands, 20 percent hard angular gravel to 3 inches, and 30 percent nonplastic fines. Five percent

hard, angular cobbles with occasional boulders to 24 inches exist within the overburden. There are no sand and gravel deposits at or within short distances from the sites.

In the reservoir area at the upper swamp (site 1), organic accumulation more than 24 feet thick was measured. Beneath the beaver pond (site 2), organic accumulation was found to be up to 22 feet thick. Samples taken in the upper four feet consisted of brown muck with a strong organic odor and greasy feel. The sphagnum moss is in a very advanced state of decomposition.

The channel work will be located across the high terrace of the Connecticut River. For the most part the surficial material in this area consists of the following: up to 2.5 feet of medium consistency organic silt, muck and silt over 0 - 3.5 feet of impervious compact silt over very loose, fairly well-graded fine to coarse sands.

The water table along the stream lies within 1 to 2 feet of the land surface. Because of the high water table and the presence of very loose sand material, slope stability of the channel may be a problem, primarily during construction. Water will drain quickly from the sand aquifer and may cause sloughing of the material from the side slopes as channel excavation proceeds. Use of the proper construction techniques, described earlier, will reduce the problem.

Water from this aquifer will continue to move into the channel through the side slopes after excavation until a new state of equilibrium develops. The effect of ground water levels resulting from lowering the channel bottom were estimated using the modified ellipse approach as outlined in the SCS National Engineering Handbook, Section 16, Drainage of Agricultural Land. Analyses indicate that during low-flow periods, ground water levels within 500 feet of the channel would be lower than they are under present conditions. During high flows or periods of heavy rainfall, the loss of drawdown head or the rapid infiltration of rainwater would nullify this effect but would contribute to less frequent flooding.

Investigations were of sufficient intensity to provide adequate preliminary design and cost estimates for the proposed works of improvement. Detailed geologic investigations will be conducted for final designs.

Archeological, Historical and Architectural

The National Register of Historic Places and other literature has been reviewed. Consultation has been made with the New Hampshire State Historic Preservation Officer, Lancaster Historical Society, Lancaster Conservation Commission, Lancaster Planning Board and other local interested citizens. In addition on-site field surveys were conducted by professionals for archeological, historical and architectural values. The project actions involving the culvert and the railroad bed are based on recommendations by the preservation officer and historical consultant.

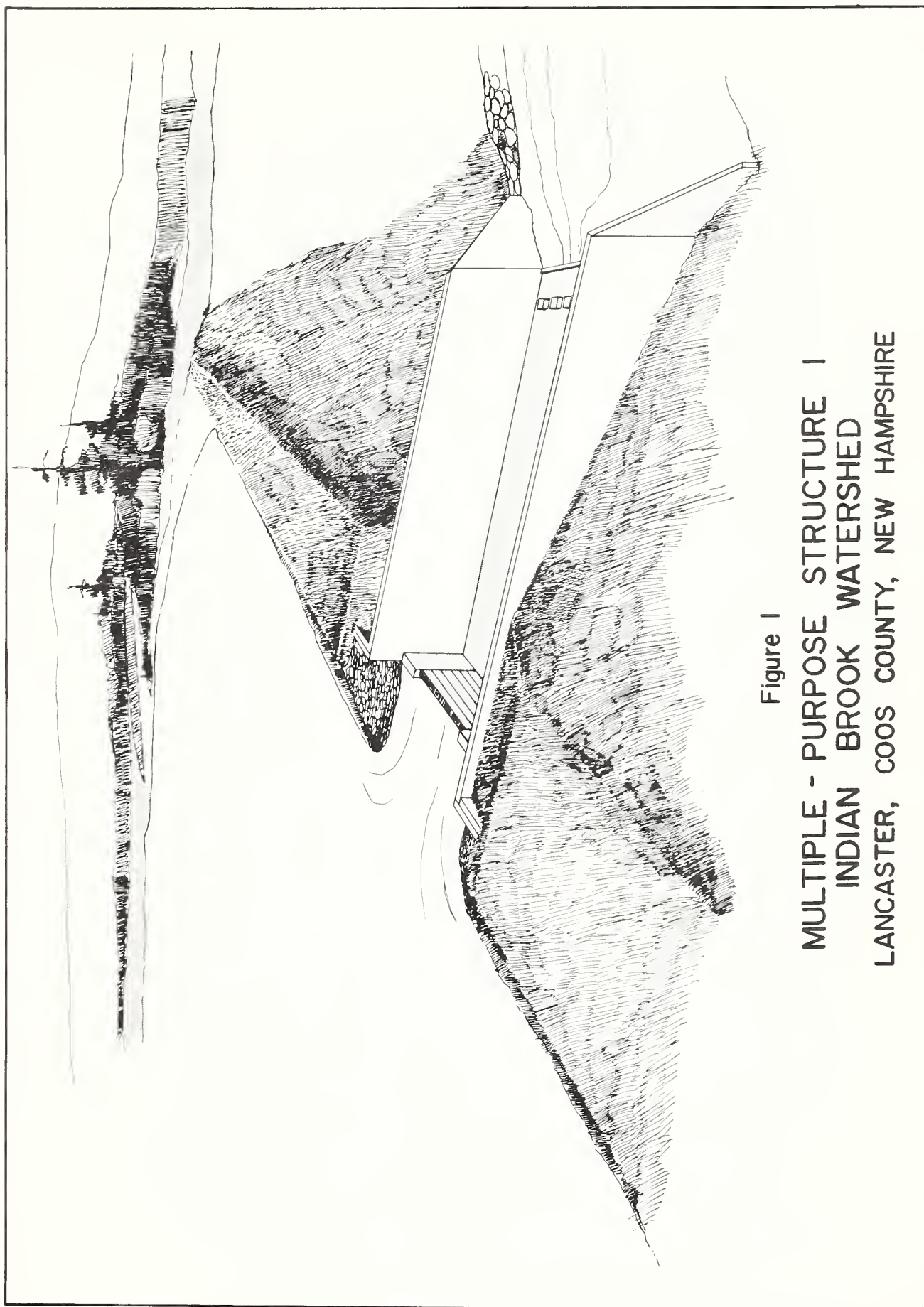


Figure 1

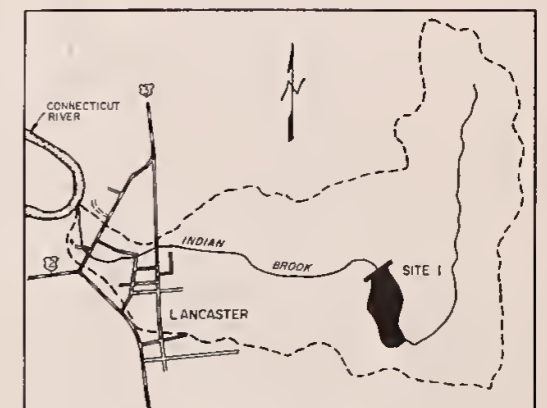
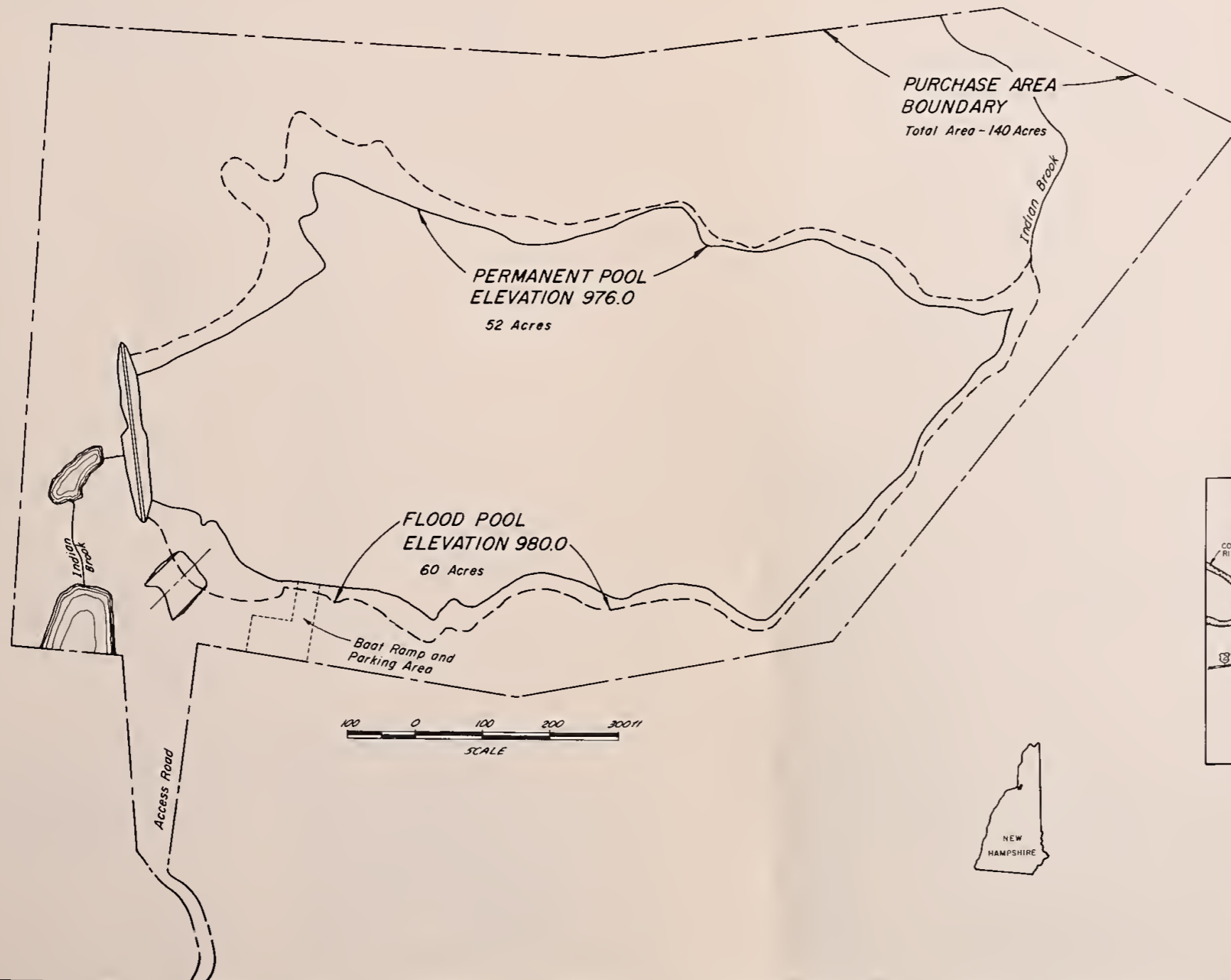
MULTIPLE - PURPOSE STRUCTURE 1
INDIAN BROOK WATERSHED
LANCASTER, COOS COUNTY, NEW HAMPSHIRE

INDIAN BROOK WATERSHED

COOS COUNTY, NEW HAMPSHIRE

SITE NO. 1

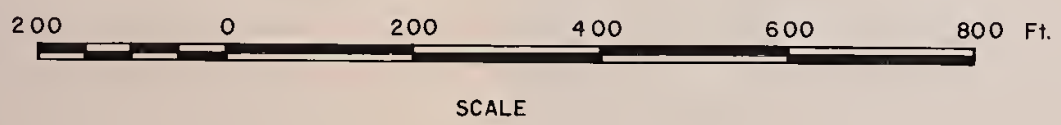
FISH AND WILDLIFE DEVELOPMENT



LOCATION MAP



Figure 2



- LEGEND**
- 100 Year Flood Plain - Indian Brook, Present Conditions
 - 100 Year Flood Plain- Indian Brook, With Project
 - 100 Year Flood Plain- Connecticut River

URBAN FLOOD PLAIN LANCASTER, N. H. INDIAN BROOK WATERSHED			
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE			
Designed G. S. Swann		Date 8/70	Approved by
Drawn M. Makeman		Date 5/70	Title
Traced		Sheet No.	Drawing No.
Checked		of 1	

Figure 3



Location Map

71°30'



44°30'

LEGEND

- First Class Roads
- Second Class Roads
- Unimproved Road
- Logging Railroad Bed
- Railroad
- Stream
- Watershed Boundary
- Drainage Area Controlled by Structure
- Area Benefited
- Drainage Area in Acres

PROJECT MEASURES

- Floodwater Retarding Structure
- Multiple-purpose Structure (FW - Fish and Wildlife Development)
- Channel Improvement for Flood Prevention

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PROJECT MAP INDIAN BROOK WATERSHED COOS COUNTY, NEW HAMPSHIRE

October 1971



